STAND CHARACTERISTICS OF SELECTED ASPEN SITES ON PRAIRIE CITY RANGER DISTRICT, MALHEUR NATIONAL FOREST

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Preface

The primary objective of this report is to summarize data collected in 116 aspen stands on Prairie City Ranger District from 1999 through 2001. The sections on aspen ecology, project objectives, area description, problem analysis, methods, and literature review were taken directly from Aspen Ecology and Rehabilitation in Eastern Oregon (Wall et al, 1999). The rest of the report presents summaries of and raw data for aspen stands surveyed from 1999-2001. This information will enable land managers to prioritize stands for rehabilitation efforts as well as guide future work in this unique habitat.

Aspen Ecology and Rehabilitation in Eastern Oregon

Introduction

It is generally accepted that aspen stands in the Blue Mountains are in an ongoing state of decline. In some cases only one or two trees remain in the stand, and it is reasonable to conclude that extensive stand loss has occurred during the last several decades. Aspen in the Blue Mountains did not exist in extensive (several hundred acres) stands common to the Rocky Mountains and Great Basin. Aspen typically occur as isolated stands in the uplands where soil and moisture conditions were favorable, which often involved perched water tables, and as stringers along stream corridors. Reasons for the decline of aspen are complex but are frequently attributed to fire suppression, conifer encroachment, past and present herbivory (elk, mule deer, and cattle), climatic stress and interactions of the aforementioned possibilities. Particularly important is the role of herbivory as fencing to exclude elk, mule deer and cattle increases the cost of rehabilitation efforts.

Aspen stands enhance biodiversity at the landscape level and provide habitat for a variety of birds and mammals. However aspen stands, through mortality and lack of recruitment, are declining to smaller and smaller core areas and fragments. Important to restoration is knowledge of past aspen stand physiography and structure, and identification of factors contributing to the decline of aspen. Aspen stands, because of their lack of regeneration by seedling establishment, are restricted to present locations. Therefore the only way to retain aspen as a component of the Blue Mountain forests is to reinvigorate existing stands. Given the aforementioned possibilities attributed to the decline of aspen, several rehabilitation methodologies are being employed to restore stands. These methods have a high cost per acre and due to limited monitoring across public and private agencies their effectiveness has not been determined at the landscape level. Therefore, it is desirable to evaluate methodologies used and develop an intensive and statistically designed study to evaluate the best possible rehabilitation practices. Increasing the general knowledge base of aspen ecology should also assist in developing the most effective rehabilitation methods.

Project Objectives

The primary objectives are:

1) Field reconnaissance of existing stands in the study area with emphasis on identifying historic extent of aspen.
2) Monitoring ongoing USFS inventory work.
3) Assisting or supplementing ongoing USFS inventory work in locating stands and sites.
4) Describe stand structure, age, and conifer encroachment of existing aspen stands.
5) Identify and evaluate exclosures; and previous, ongoing, and planned stand treatment projects.

6) Obtain funding for an extensive proposal to study aspen ecology and evaluate and monitor rehabilitation methods in these unique environments.
7) Continue to work with all interested potential partners or cooperators, and volunteers.
8) Develop a progress report for the RMEF, USFS, BLM, ODFW, and BMEI that summarizes the field work. EOARC staff will be available for presentation of results to cooperators.

From the stated objectives we hope to 1) develop a better understanding of the past and present status, and trend of aspen; 2) identify aspen rehabilitation methods and evaluate their level of success; 3) identify factors leading to aspen decline; 4) develop a working partnership between EOARC, BLM, and USFS to initiate an intensive study of aspen in the Blue Mountains that will provide managers with methodologies that have a high expectation of success and increase the knowledge base of aspen ecology.

Area Description

The Burns, Bear Valley and Prairie City Ranger Districts of the Malhuer National Forests lie generally south of the cities of John Day and Prairie City and north of Burns, Oregon. The Three Rivers Resource Area, Burns District, BLM abut the Malhuer National Forest study areas on the south. The area is dominated by ponderosa pine forest with north slopes at mid and higher elevations having mixed conifer communities. Lodgepole pine communities are also present at the mid and higher elevations. Aspen stands are found as stringers along stream channels, adjacent to wet meadows, or as isolated communities in the uplands where soils and moisture permit. Elk, mule deer, and cattle are common grazers over the entire area. The study area lies within the Murderer's Creek, Silvies, and North Malheur Big Game Management Units where, in 1997, hunters harvested 657, 860, and 435 elk, respectively.

Problem Analysis

Aspen communities have been identified as important habitat components of the Blue Mountains. Similar categorization has occurred for aspen throughout the entire western U.S. Aspen stands provide ecological as well as aesthetic diversity to the landscape; forage and cover for ungulates; nesting, feeding and migratory habitat for a variety of avian species; and habitat for a wide variety of small mammals. Additionally, they are sought out by people as camp sites. Generally, aspen communities are declining throughout the western U.S. Various hypotheses have been expressed as to the cause thereof. Herbivory by elk, deer, and cattle has been implicated as a primary factor in aspen decline. Fire suppression, conifer encroachment, and climatic cycles have all been implicated as well. There is an immediate need to reverse this trend, as aspen may be currently present at only 5% of pre-settlement occurrence. Remnant aspen stands typically occur as small units of perhaps as little as one to five stems and less than one acre in size in the Blue Mountains. Due to the high palatability of aspen to ungulates, most rehabilitation methods in the Blue Mountains include fencing. Burning, conifer thinning, and removal of mature aspen stems are treatments commonly used separately or in aggregate to regenerate stands through the action of sprouting. Costs of projects can

vary from $1,000 to $1,500 per acre. Due to this high cost and the number of aspen stands, there is a need to identify the most successful methods of rehabilitation.

Sample Methods for Assessing Response to Aspen Treatments

A. Sampling methodology for initial-visit sites

Site selection

1st Priority

Aspen sites that have been treated or will be treated for the purpose of enhancing stand vigor and regeneration.

2nd Priority

Aspen sites that are not scheduled for treatment. These sites allow for comparisons with treated aspen as well as assessing condition and trend of aspen across the landscape.

Site information

Each site sampled is assigned a permanent identification number for the purpose of record keeping and communication. Sites previously numbered are not re-numbered. The date sampled, general location, landform, treatment type, percent lost, and vigor rating of the site is recorded (see Appendix 1).

Landform types have been broken down into the following categories:

1. Seep. Drainage areas where water is evident in the soil but not free flowing or standing as in riparian classification.
2. Non-seep, but sub-drainage. Drainage areas where water is not evident above ground.
3. Riparian. Areas adjacent to springs, streams, ponds, or other types of open flowing or standing water etc.
4. Meadow.
5. Upland. Areas with no apparent ties to concentrated water drainage or source.

Treatment types will vary but may include the following:

1. Four wire fence.
2. Big game wire fence.
3. Buck and pole fence.
4. Cages.
5. Aspen cut.
6. Aspen burned.

7. Conifers cut.

All aspects of a treatment are recorded. For example a site may have a 4-wire fence with 9 cages and half of sub-dominant conifers cut.

To determine where the aspen stand once existed the following criteria were used:

1. Distribution of dead down aspen.
2. Distribution of outlying aspen sprouts/saplings.

By using these criteria a visual estimation is made as to what proportion of the stand has been lost.

Vigor of aspen sites are assessed following methods created by Mike Tatum, Silviculturist PCRD (see Appendix 2).

Sampling

Plot size

A 30m (98ft) diameter circular plot was located inside the stand to be sampled. The plot is located to best represent the site as a whole.

Density

Aspen and each species of conifer are separated out into the following categories and counted.

1. Sprout/sapling. Trees less than 2m (6.5ft) tall.
2. Sub-dominant. Trees greater than 2m (6.5ft) tall but not part of the co-dominant canopy.
3. Co-dominant. Classed as height of adult aspen.
4. Dominant overstory. Conifers taller than co-dominant.

Standing dead and large down dead aspen are categorized in one of the above categories and counted. Note that only those down dead aspen that were rooted within the circular plot are recorded. In sites where aspen sprouts/saplings are very dense a 15m (49ft) circular subplot located in the center of the existing larger plot was used. The subplot is sectioned into four equal quarters. Two quarters are randomly selected and the aspen sprouts/saplings are counted within these two quarters. If this is done then it is noted on the data sheets next to where these tree densities are recorded (i.e. sampled ½ 15m).

Canopy cover

A spherical densiometer is used to determine aspen and conifer canopy cover for each plot. Conifer canopy cover is not separated out by species but is measured as a total. Densiometer measurements are recorded for five locations; one reading in the

center of the circular plot and additional readings at the north, south, east, and west edge of the circular plot.

Canopy height

Sprout/sapling and co-dominant aspen and co-dominant and dominant conifers canopy heights are measured and recorded. If aspen sprout/sapling class shows evidence of being browsed (i.e. multi stemmed hedged appearance, terminal leaders absent) it is recorded. If current years growth has been browsed then it is recorded.

Stand age

In every site sampled, five of the largest aspen were cored at dbh with an increment wood corer. Ten conifers are cored at dbh with 5 being in the sub/co-dominant class and 5 in the dominant class. Note that cored trees do not have to be inside the circular plot and that 5 of each class may not be present to core. Record how many of each class was cored. Each individual tree core is labeled with the forest, district, site number, tree species (i.e. conifer or aspen), dbh, and class (i.e. co-dominant or dominant). Cores were mounted, sanded, and rings counted. All aspen cores were stained prior to counting.

Plant component

The primary and secondary species of shrubs, grasses, and forbs are recorded and ranked according to the following cover classes:

1. <1%
2. 1-5%
3. 5-15%
4. 15-25%
5. 25-50%
6. 50-75%
7. 75-95%
8. 100%

Site geography variables

Slope, position on slope (crest, mid, toe), aspect, elevation, and micro-relief (convex, concave, flat) are all recorded.

B. Sampling methodology for re-visit sites:

Stands visited in 2001 for the second time were selected by the district silviculturist. These sites had been previously inventoried in 1999 or 2000. The following methodology was used for re-visit sites.

A 30m diameter circular plot was located to best represent the site as a whole. A 15m diameter plot was used if the stand was not large enough to accommodate a 30m plot. Total counts of live aspen sprouts, live aspen sub-dominants and live conifer sprouts were recorded. Where the density of aspen sprouts was very high, a 15m subplot was used. The 15m subplot was sectioned into four equal-sized quarters. Two quarters were randomly selected, and the aspen sprouts were counted in those two quarters. The height range of aspen sprouts was recorded. Percent of aspen sprouts browsed in the past (historic) and during the current year were recorded for each plot. Relative vigor of aspen was assessed for each stand according to Tatum
(see Appendix 2).

Literature Review of Aspen

Distribution

Quaking aspen (*Populus tremuloides*) is the most widely distributed native North American tree (Baker 1925, Fowells 1965, Jones 1985, Weber 1990). Aspen thrives from the hardwood forests of eastern North America to the coniferous forests in the Rocky Mountain west. It grows in a wide variety of sites varying from gentle slopes with deep soils to valley bottoms, riparian areas, and steep high talus ridges (Morgan 1969). Soil types vary from loamy sands to heavy clays (Shepperd 1986).

Mueggler (1988) stated that aspen-dominated woodlands constitute a major portion of forest types in the interior West. The Intermountain Region contains over 1 million ha of aspen forests. DeByle et al. (1989), reports 3 million ha of aspen in the West. These forests range from small isolated groves to broad expanses of pure and mixed stands.

Utah's extensive stands of aspen occupy more of its forested land (25%) than any other tree species (Mueggler 1988; Jones 1985). Idaho and western Wyoming combined have 323,000 ha of widely distributed isolated stands (Mueggler 1988). Idaho's aspen occupy a greater diversity of geographic areas than in any of the other intermountain states (Jones 1985).

Aspen is associated with montane and subalpine vegetation types along a broad elevational and moisture gradient (Shepperd 1986). Elevation levels of aspen in the Intermountain Region range from a high of 3,350 m in Utah to a low of 914 m in central Idaho (Jones 1985). Across this wide elevation zone annual precipitation ranges from 40 to 100 cm per year, most being received as snow (Shepperd 1986).

Amacher and Bartos (1997) currently estimate that aspen dominated lands in the Intermountain West have decreased by 60% since European development. In the Rocky Mountain region, Utah alone has had an approximate 60% decline in aspen dominated landscapes due to conifer encroachment (Bartos and Campbell 1998). Kay and Wagner (1996) state that aspen in Yellowstone Park have declined by 85% since 1947 due to ungulate browsing. Bartos and Campbell (1997), state that when conifers overtake aspen

communities, less water is available to the watershed, under-story biomass vegetation is significantly reduced, and the diversity of wildlife and plant species declines.

Comparing seral and stable aspen communities

The main question regarding succession is whether present-day aspen stands are seral or climax communities. To be considered climax, a species must reproduce within the community and/or provide an environment unfavorable for the successful invasion of a potential climax species (Morgan 1969). In general, aspen has been regarded as a fire-induced successional species that dominates a site until more shade tolerant conifers begin replacing the stand (Mueggler 1985a; Bartos 1973; Morgan 1969). Without periodic fires, conifers reproduce in their own shade, out-compete aspen, and move the site's composition towards climax. Such conifers may include *Picea engelmannii, P. pungens, Abies lasiocarpa, A. concolor, Pinus contorta, P. ponderosa, Pseudotsuga menziesii,* and *Juniperus occidentalis*.

Long fire intervals are required if conifers are to replace aspen stands. Long intervals enable conifers to establish, reproduce, and become the dominating climax species. However, fire interval length can vary. Depending on the site and the conifer species, conifers can replace aspen stands within a single generation or up to a 1,000 years in the absence of fire (Mueggler 1985a). A reliable determinant of a seral aspen site is the presence of an uneven-aged conifer under-story (Mueggler 1985a, Peterson and Squires 1995).

For conifers to replace an aspen stand there must be an initial population to provide a seed source. Conifers do not reproduce vegetatively like aspen, so without a seed source, they will not establish. The viability, fecundity, and number of seed help ascertain the rate of conifer establishment.

An aspen stand classified as a climax community has key indicators of stability. Stands with an uneven-age structure in the canopy over-story indicate trees are reproducing in the absence of disturbance. The fact that the stand is reproducing in its own shade may qualify a stand as climax. However, there must be lack of successional change in the under-story and the absence of more shade tolerant trees (Mueggler 1985a, Shepperd 1986). A stable aspen community may contain a few scattered conifers due to highly unusual and temporary conditions that favored their establishment. However, conifers must be prominent with an uneven-aged under-story to suggest a seral aspen stand (Mueggler 1985a).

Pure aspen stands exist in which no conifers are present. On Steens Mountain in southeast Oregon, no conifers (western juniper) are found above 7,000 ft. Aspen stands above this elevation are exempt from shade tolerant conifers and further successional development. These stands can be classified as climax.

Daubenmire's polyclimax theory suggests that aspen stands that burn at regular fire intervals can be classified as a pyric climax. Regular fire intervals deter conifer development and allow aspen regeneration to continue. Without periodic disturbances, stands are considered seral and succession of conifers will progress (Daubenmire 1968). Environmental conditions determining aspen's role, as a seral or climax species have not been determined (Mueggler 1988).

Asexual reproduction

Aspen is unique in its ability to reproduce asexually and sexually. In the Intermountain Region, aspen mainly reproduce asexually through suckering, a process in which stems are produced from the connected underground parent root system (Schier 1975, Schier and Smith 1979, Schier et al., 1985a). These stems, or ramets, are genetically identical to each other. Because of this, distinct aspen stands are often referred to as clones. The production of suckers greatly increases when over-story stems are removed by disturbance such as fire, wind, and cutting. Suckers are also produced when over-story stems die from disease or old age. This vegetative method of reproduction results in clones of genetically identical trees and stands of a single genetic individual. Because of asexual reproduction, stands or clones can be quite large. Many believe that the largest living organism on earth is a clone of aspen named Pando in south-central Utah (Grant et al. 1992, Grant 1993, McLean 1993, Mitton and Grant 1996). Through time, ancient clones could result from asexual reproduction. Figures of 10,000 to 1 million years old have been proposed (Barnes 1966, Kemperman and Barnes 1976, Mitton and Grant 1996).

Sucker development in aspen roots is suppressed by auxins transported from aerial parts of the tree (Schier 1976, Schier et al., 1985b). The loss of the over-story stems causes hormonal imbalance and apical dominance is lost. Auxin levels decline and buds located just below the soil surface on lateral roots are stimulated to sprout and grow (Schier 1972, Schier 1976, Shepperd 1986). Under favorable conditions, almost any section of an aspen root can sucker since lateral roots have thousands of suppressed shoot primordia (Schier et al., 1985b).

Undisturbed aspen stands that contain large numbers of suckers indicate that apical dominance is not absolute (Schier et al., 1985b). Auxins are unstable compounds that are translocated over lengthy distances from buds and young leaves down to roots. As auxins travel down the stems, apical dominance is weakened due to auxin immobilization, destruction, and age (Schier et al., 1985b). Periods can occur in the growing season when apical dominance is weak enough to allow suckering. This allows stands to reproduce without disturbance. This supports the earlier discussion of climax aspen stands.

Elongating suckers depend on parent root reserves until they can photosynthesize. Sucker population of a clone is related to levels of reserved carbohydrates and hormonal growth promoters in the roots (Schier 1976, Schier et al., 1985b). Once the sucker begins assimilation of carbon, additional roots sprout from the parent root near its base. The degree of dependence on parent roots declines as these roots develop to provide water, nutrients and support for that specific stem (Jones and DeByle 1985).

Soil temperature is considered the most important environmental factor controlling suckering (Steneker 1974, Schier 1976). Increased temperatures raise cytokinin levels in root meristems and degrade auxin concentrations. Suckering is then stimulated by the higher ratio of cytokinin to auxins (Schier et al., 1985b). Canopy removal allows greater amounts of light to reach the soil surface, which increases soil temperatures, and suckering. Also, stand-replacing fire can leave black soil surfaces that are conducive to light absorption and soil heating.

Several researchers have studied sucker regeneration after clearcutting, partial cutting, scarification, and girdling of adult aspen. Schier and Smith (1979) found that clearcutting resulted in the highest number of suckers. In Colorado, Crouch (1981) found that clearcutting mature aspen resulted in 18,000 sprouts/acre after the first season of growth and 8,000 sprouts/acre after two growing seasons. After two growing seasons sprouts were 4.4 feet tall. In Arizona, Jones (1975) found that clearcutting mature aspen resulted in 14,000 suckers/acre after the first season of growth and 10,700 suckers/acre after four growing seasons. After four growing seasons suckers were a maximum of 10.5 feet tall. Jones (1976) states that partial cutting of adult aspen results in an inferior replacement stand. However, clearcut stands have rapid and abundant regeneration. Schier and Smith (1979) concluded partial cuts had less than 50 percent of regeneration as clearcuts. Girdling was not as affective as cutting and few suckers survived longer than 12 years on girdled plots. Scarification had no measurable effect on sucker production. Smith et al. (1972), also found that girdled plots of adult aspen resulted in far less sucker production versus cut plots of adult aspen.

Sexual reproduction

Aspen is dioecious, with male and female flowers borne on separate trees. Flowering generally occurs in early spring before the appearance of leaves (Jones and DeByle 1985). Aspen seed production and subsequent colonization strongly depends on favorable climatic and microclimatic conditions. Reproductive maturity is reached at 10 to 20 years of age. Peak seed production occurs at 50 years with varying years of light to heavy seed crops (McDonough 1985). A mature tree is estimated to produce 1.6 million seeds a year (Maini 1968, McDonough 1979).

Aspen's ability to produce sufficient seeds for establishment is offset by the exacting conditions required by germinating seed and seedlings (Pearson 1914, Baker 1918, McDonough 1985). Factors involving germination, viability, and water stress, affect seedling growth and survival (McDonough 1985; Shier et al., 1985a; Morgan 1969). Temperatures greater than 25 C at the soil surface inhibit seed germination. Elevated temperatures from fire blackened soil surfaces stimulate sucker sprouting but are not conducive to seed germination. In a dry, warm environment seed viability typically lasts 2-4 weeks after maturation, limiting the time for establishment (McDonough 1985; Morgan 1969). Exposure of seed to high temperature and humidity results in a rapid loss of germability (McDonough 1979). Additionally, root hairs from the germinating seed dry rapidly if they fail to quickly penetrate the soil surface and make contact with water (McDonough 1985). Thus, conditions for establishment are delicate. In the Intermountain Region, current climatic conditions are not favorable for sexual reproduction. McDonough (1985) and Mitton and Grant (1996) have proposed that climatic conditions favorable for seedling establishment have not been present in the West for the past 10,000 years, or since the last glaciation.

Age structure

Aspen stands can be categorized as young, mature, old, and uneven-aged. The following paragraphs describe each age class:

Young stands are found where a recent disturbance or disease has killed the over-story and triggered vegetative reproduction (Shepperd 1986). Disturbance such as fire removes the stand in a single event allowing for uniform sucker growth with an even age distribution. These stands can contain 49,000-75,000 suckers/ha that thin over time because of competition for sunlight (Jones 1976, McDonough 1985).

Mature even-aged stands are 80 to 100 years old with tree height ranging from 9 to 30 m (Mueggler 1985). An estimated two-thirds of the aspen stands in the Intermountain Region exceed 95 years of age (Mueggler 1989). Stands reaching ages greater than 120 years are classified old (Bartos and Mueggler 1981). Some stands have been reported to persist for more than 200 years (Bartos and Mueggler 1981). At this point, deterioration becomes evident and trees begin to die (Jones and Schier 1985).

Uneven-aged stands contain multiple age levels of young, mature, and old trees. These stands form under stable conditions where the over-story progressively dies from age or disease and is consecutively replaced by suckers (Mueggler 1985). Uneven-aged stands can also be found where individual clones expand and invade into adjacent grass or shrub communities (Mueggler 1988).

Stand dynamics

Mueggler (1988) states that most aspen communities are multi-layered because light penetration into the aspen over-story is sufficient to support abundant undergrowth. This undergrowth is comprised of shrubs, perennial herbs, and annuals. Aspen stands can be complex with several layers of conifers, shrubs, tall forbs, low forbs, and grasses. In contrast, stands can be very simple with even-aged aspen and a general assembly of grasses. He further shares that among the hundreds of plant species present in aspen communities of the Intermountain Region, very few can be considered representative of the aspen type. He feels that this reflects the ability of aspen to serve as an over-story dominant under a broad range of environmental conditions.

In discussing his methods of classifying aspen community types, Mueggler (1988) does generalize those plant species most likely to be found. Shrub genera include: *Symphoricarpos, Rosa, Amelanchier, Prunus*, and *Berberis*. Forb genera include: *Thalictrum, Osmorhiza, Geranium, Aster, Lathyrus, Achillea, Galium*, and *Senecio*. Graminoid genera include: *Agropyron, Bromus, Elymus, Poa*, and *Carex*. Of 2,100 aspen stands sampled by Mueggler (1988) only four plant species occurred more than half the time. These include: *Symphoricarpos oreophilus, Agropyron trachycaulum, Achillea millefolium*, and *Thalictrum fendleri*.

Mueggler (1985) points out that seral stands of aspen giving rise to conifer development become depauperate of previous plant species. When the conifer layer thickens, less light penetrates to lower levels of the under-story and competitive relationships are altered. This results in a progressive decrease of under-story shrubs and herbs.

Soils

Aspen is found on soils derived from basalt, granite, sandstone, and limestone (Berndt and Gibbons 1958, Jones and DeByle 1985). Aspen grow on almost any soil type originating from these parent rocks. This broad amplitude of growth success is attributed more to environmental factors than actual soil types (Jones and DeByle 1985).

According to Jones and DeByle (1985), aspen has been observed on a full spectrum of landforms, including bottoms of draws, tops of ridge crests, and on tops of mesas and plateaus. Aspen have been observed on gley soil next to marshes, on 73% slopes of an old avalanche track, and on old talus with very thin stony soils. This wide spectrum of aspen stand locations explains why numerous types of soils are represented. However, aspen does grow larger and faster at the foot of slopes and on benches. These areas are well suited for aspen because they can contain rich, deep soils with plentiful moisture (Baker 1925, Jones and DeByle 1985). Heights depend upon site quality and clonal genotype.

Bartos and Johnston (1978) found the highest concentration of nutrients in aspen were in leaves and new twigs. Bartos and DeByle (1981) state that the annual return of leaf and twig matter to the soil surface is a major contribution to the organic matter and nutrient content of soils under aspen. Their study revealed that nearly 1,800 kg's per hectare of aspen leaves and twigs fell each year from stands with basal areas ranging from 17 to 25 square meters per hectare. Further study revealed that a 42% weight loss in the litter crop occurred after the first year. Such high decomposition rates suggests these communities have rapid nutrient cycling. On deep, well-drained soils, varied rooting depth of aspen allows for effective withdrawal of large quantities of available nutrients. These nutrients are incorporated into biomass. A large proportion of that biomass is annually dropped as litter to the soil surface where it decays rapidly and returns nutrients to the mineral soil. This cycle builds and enhances soil (Jones and DeByle 1985).

Aspen leaves typically have a higher nutrient content than conifer needles and are able to decay faster (Duabenmire 1953, Troth et al. 1976, Bartos and DeByle 1981, Jones and DeByle 1985). Herbaceous undergrowth is usually more productive under aspen than under conifers. This provides for even more litter input to the soil (Morgan 1969).

Soil studies done in northern Colorado found the A1 soil horizon under aspen was darker and contained more organic matter than under adjacent coniferous stands (Hoff 1957, Jones and DeByle 1985). Another study in northern Utah revealed that the top 6 inches of mineral soil under aspen had 4% more organic matter, slightly higher pH, more available phosphorus, and a higher water holding capacity than the soils of adjacent stands of shrubs and herbaceous vegetation (Tew 1968, Jones and DeByle 1985).

Jones and DeByle (1985) believe that if aspen occupies a site for several generations, an aspen type soil develops. If the aspen is seral to conifers, then the soil exhibits influences of the vegetation that occupied the site for the longest period of time. A single generation of conifers may result in a leached, light colored A2 horizon. This layer would be darker and more nutrient rich under aspen dominant sites.

Amacher and Bartos (1997) conducted a study where they sampled soils that at one time were dominated by aspen. Due to lack of fire, wildlife use, grazing livestock, or natural succession, conifers or sagebrush had largely replaced them. They measured pH, exchangeable cations, extractable phosphorus, total organic carbon, total nitrogen, and organic matter content of soils developed under conifers, mixed conifer-aspen, and aspen stands. Their studies found no significant differences for these measured soil properties.

They felt that the soils had not been altered significantly to inhibit new aspen development. However, soils were sampled in the interspaces between trees, not directly under trees (personal communication). Wall (1999) sampled soils that once were dominated by aspen but presently were dominated by western juniper. Soils were collected directly under aspen and western juniper trees. The C:N ratio and pH proved to be significantly greater in soils collected under western juniper. Soils influenced by western juniper also had higher amounts of salts, lime, and sulfate, and lower amounts of magnesium, iron, manganese, and copper.

Fire

Fire is a natural event in aspen communities that plays an important role in perpetuating stands (Baker 1925, Schier 1975, Bartos and Mueggler 1981; Brown and DeByle 1987; DeByle et al. 1987, DeByle et al., 1989). It is responsible for the abundance of aspen in the West (Jones and DeByle 1985; Romme et al., 1995). Fire stimulates the production of suckers by nullifying apical dominance through the removal of the over-story (Schier 1975, DeByle et al. 1987, Bartos et al., 1991). Prior to European settlement fire occurred regularly at varying intervals. With the settlement of the West, these intervals have lengthened due to fire suppression and alteration of fuel loads. Today fire in aspen stands is considered an unusual event (DeByle et al., 1987, DeByle et al. 1989). The lack of fire has resulted in old decadent aspen stands throughout the West (Schier 1975, Jones and DeByle 1985, DeByle et al., 1989).

The current dominance of aging, decadent aspen stands concerns land managers (Basile 1979, DeByle et al. 1989). Managers desire a more favorable multi-aged mosaic of aspen stands (Harniss and Bartos 1985, DeByle et al. 1989). Therefore steps are being taken to rejuvenate decadent stands on public lands. Re-introduction of fire through prescribed methods kills invading conifers and removes over-aged aspen. Vigorous growth of the new even-aged root suckers enhances the favorability of the community.

Aspen stands require certain conditions for fire to occur. They do not readily burn as other vegetation types that have evolved flammable characteristics (Mutch 1970, Bailey and Anderson 1980, Jones and DeByle 1985, DeByle et al. 1987). In the Great Basin adjacent mountain big sagebrush stands burned every 12 to 25 years (Miller and Rose 1999). However, aspen only burned during very severe fire events. A dense under-story of conifers or shrubs combined with dry conditions favor a hot fire with rapid spread. Many aspen stands lack these larger fuel loads and only have fine herbaceous material, fallen leaves, occasional downed stems, and a few shrubs or conifers (Jones and DeByle 1985). Fires that occur in these fuel loads are generally lower intensity creeping ground fires and not the higher intensity fires of conifer/shrub stands. Jones and DeByle (1985) state that aspens sensitivity to fire negates the difficulty of these stands to burn and allows for vigorous sucker regeneration. However, Basile (1979) found that although fire increases suckering, the response is highly variable.

Key factors that influence fire temperatures include fuel type, quantity, spatial distribution, moisture content, and weather conditions prior to and during burning (Bailey and Anderson 1980). Aspen is not readily burned due to relatively high fuel moisture, but because its bark is thin and green without protective corky layers, it is very sensitive to fire heat. Fire kills trees or inflicts damaging scars that lead to root and heart rot

(Baker 1925, Jones and DeByle 1985). Fire that is able to kill the over-story stimulates profuse suckering (Bartos and Mueggler 1981). In Wyoming, severely burned sites generated the most suckers, 2 years after the fire. Moderate to light burned sites produced the most suckers, 1 year after the burn. On both sites, suckers numbered from 29,900 to 150,000 stems per hectare (Bartos 1979, Jones and DeByle 1985). It is suggested that 10,000 to 20,000 suckers/ha are needed initially to re-establish aspen on burned sites (Bartos et al., 1991).

Animal impacts

Aspen communities regularly produce more that 2,000 kgs of forage/ha (Houston 1954, DeByle 1985a). This rivals the production of grasslands and can exceed neighboring conifer communities by 6 times (Reynolds 1969). Young aspen is nutritious, and when abundant, will make up a substantial portion of livestock and wild ungulate diets (Mueggler 1985b). Today the primary consumptive use of aspen growth and under-story is grazing by cattle and sheep (DeByle 1985a).

In a given area, the proportion of aspen acreage is relatively small when compared to the overall acreage available for livestock use. However, these stands can be and have been greatly affected by livestock herbivory. Cattle and sheep contribute different methods of disturbance. Cattle stocking rates resulting in utilization levels of 50-60% of the palatable forage has negligible affects in both mature and young sucker stands of aspen. In contrast, similar levels of grazing by sheep will damage and kill the aspen suckers (Sampson 1919, DeByle 1985a). Sheep browsing directly impacts aspen in the early sapling stage by reducing growth, vigor, and numbers (DeByle 1985a). Repeated over-browsing will eliminate an aspen stand. Sampson (1919) states that aspen suckers need to be 1.2 m tall for terminal leaders to escape sheep utilization; suckers need to be greater than 1.5 m tall for terminal leaders to escape browsing by cattle. Utilization of aspen and terminal bud removal is greater on sites used by both domestic and wild ungulates versus utilization by only one ungulate type (Smith et al. 1972).

As a growing season progresses, cattle increase use of herbaceous species in aspen stands as the availability of forage outside the stands declines (Fitzgerald et al., 1986). On the other hand, sheep select for the forage in these stands regardless of the season. Despite season of use and foraging, cattle do negatively impact these sites by seeking shade and constantly trampling stands. Repeated sucker damage progressively deteriorates the stand until only a few decadent trees remain. Fitzgerald and Bailey (1984) found that on burned aspen stands two different plant communities resulted from two cattle grazing regimes. After the first year, early grazed plots consisted of 29% aspen and 28% grass, while late grazed plots had 2.5% aspen and 18% grass. They concluded heavy browsing by cattle in August reduces aspen suckers following fire.

Reduced fire intervals in aspen stands are partially attributed to removal of under-story vegetation by livestock (Jones and DeByle 1985). Normally this vegetation dries in the fall allowing for potential fuel loads to carry fire. Stands that do burn must be protected to ensure sucker survival. Fencing or piling slash can be used to deter livestock use. This gives suckers opportunity to establish and grow to a needed height of 1.5 m to protect the terminal meristems from damage caused by ungulate use (Jones and DeByle 1985).

In Arizona, Shepperd and Fairweather (1994) removed a fence surrounding a 6.5 ha aspen sucker stand. The site had been fenced for five years after clearcutting. The regenerated stand averaged 50,000 stems/ha with dominant stems over 3 m in height. By one year after fence removal, elk had caused severe damage to the stand by breaking the stems to reach the terminal foliage. Subsequently, cytospora canker infected the damaged stems. They concluded that fencing needs to remain in place 10 to 15 years due to the demand for browse associated with current high animal populations. In New Mexico, Patton and Avant (1970) state that six to eight years of protection after a fire is needed to allow suckers to escape utilization by deer and elk.

Wild ungulates, such as deer and elk, seasonally rely on aspen stands. Aspen suckers are not a significant forage source during the summer months (Canon et al. 1987). The season of primary use is during fall and winter when elk and deer seek food and thermal cover. Deer browse heavily at this time. Their average diets include 74% trees and shrubs (Kufeld et al. 1973, DeByle 1985a). Deer reside in and around aspen stands during fall and early winter until snowpack depth in the aspen zone forces them to lower elevations. Elk are larger and able to remain in aspen zones during most winters (DeByle 1985a). Their evidence of residency is regularly depicted due to elk "barking" mature aspen stems. Barking is the process of gnawing or stripping the bark for food. Elk are the primary barkers of the West, but rabbits, hares, mice, voles, and porcupines also contribute. Excessive barking can girdle trees or allow pathogenic fungi and canker to infect and adversely affect the aspen stand (Packard 1942, DeByle 1985a; Romme et al. 1995). For example, Krebill (1972) found that stands of aspen on the Gros Ventre elk winter range had an unusually high mortality rate due to the combination of pathogenic fungi, injurious insects, and physiological stress that follows bark wounding by elk. Baker et al. (1997) report that over the last century aspen regenerated only when there were less than 600 elk on the Rocky Mountain National Park's winter range. Presently there are an estimated 1,600 elk. They feel that excessive elk browsing, rather than fire suppression or climatic fluctuations, is limiting aspen regeneration. They state this was not the case prior to EuroAmerican settlement because pre-settlement elk populations were not of significant size to deter aspen regeneration.

Excessive or highly concentrated populations of deer and elk are a major concern to the health and longevity of the aspen community. Aspen communities found on winter ranges receive the most damage (Romme et al. 1995). The combination of human encroachment on winter range and subsequent fire suppression has resulted in concentrated animal numbers relying on decadent aspen stands. Prescribed fire in aspen provides a significant forage resource to ungulates within 1 to 2 years after burning (Canon et al. 1987). When a stand does burn and sprout suckers, it may be utilized too heavily due to the scarcity of suckers on the landscape. If the suckers are continually over utilized, the stand will eventually disappear from the landscape.

Insects and diseases

Aspen is host to many insects and diseases, but only a few result in significant damage. Western tent caterpillar (*Malacosoma californicum*), found throughout the Intermountain West, can defoliate large acreages of aspen in years when population densities are high. This defoliation can become severe enough to cause tree mortality.

Species of boring insects that damage or kill aspen include: poplar borer (*Saperda calcarata*), poplar twig borer (*Saperda moesta*), poplar branch borer (*Oberea schaumii*), poplar butt borer (*Xylotrechus obliteratus*) and bronze poplar borer (*Agrilus liragus*). These borers can cause severe physical damage or mortality to aspen. They also provide openings that allow cankers, fungus, and disease to infect, deform, and kill trees (Jones, Debyle, and Bowers 1985).

Sooty canker (*Cenangium singulare*) is considered the most lethal canker and is a major cause of aspen mortality in the West. Black cankers (*Ceratocystis fimbriata*) are large slow growing cankers that are seldom fatal, but cause considerable deformity. *Cryptosphaeria* is a recently discovered canker that grows rapidly and can kill stems in a few years (Hinds 1985, Shepperd 1986). Shepperd (1986) feels that the most serious cause of mortality in aspen stands is decay. Stems older than 100 years of age have the highest rate of infection. A false tinder fungus that enters through a wound to the sapwood or heartwood can cause this decay. *Phellinus tremulae* is the predominant aspen trunk rot fungus in North America (Hinds 1985).

Summary

There are many more topics and literature on aspen that are not covered in this review. Examples include: genetic diversity, forage quality, water relations, detailed physiology and morphology, silviculture of aspen, harvest methods, aspen wood products and uses, greenhouse methods of regeneration, etc. However the list of literature is a good representation that can be further investigated by individuals seeking specific information.

DATA ANALYSIS

Organization of the data set and analysis procedures

The data set was separated into two primary groups, initial-visit sites and re-visit sites. Initial-visit sites had been surveyed once, whereas re-visit sites had been surveyed a second time using a modified sampling methodology (see methods section, page 5). Initial-visit sites were further subdivided into 4 groups based on treatment type: pre-treatment/control[1] , cages & tubes, 4-wire fence, and big-game fence. The re-visit data was separated into two groups: 1) treatment present in 2001 was in place at the time of the initial survey [2]; 2) no treatment present at the time of the initial survey compared to presence of treatment in 2001.

Analyses were conducted by group except for tree ages, which were averaged across stands by structural class[3] Site-specific data for 116 aspen stands visited from 1999-2001 on Prairie City Ranger District, Malheur National Forest are presented by year in Appendices 3-5. Appendix 6 contains site-specific data for 41 re-visit sites surveyed in 2001. Appendix 7 contains data on aspen in cages for 31 sites. Appendix 8 contains

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[1] Pre-treatment, control, or no treatment all refer to the same condition.

[2] Treatment types were as mentioned for initial-visit sites.

[3] Sub-dominant: trees greater than 2m (6.5ft) tall but not part of the co-dominant canopy; Co-dominant: classed as height of adult aspen; Dominant conifers taller than co-dominant.

GPS file names for 26 aspen sites visited in 2001. Equipment failure prevented the crew from collecting GPS information on the remaining 23 sites.

An expansion factor of 14.147[4] was used to convert plot counts to a per-hectare (ha) basis.[5] Estimated tree ages were based on tree-ring counts from cores. Descriptive statistics[6] were generated for twenty-six variables, and frequency[7] tables were generated for nine categorical variables[8] for the initial-visit sites. Raw data for 3 variables was compared for re-visit sites. S-PLUS 2000 was used for all calculations unless otherwise indicated (MathSoft, 2000).

RESULTS

INITIAL-VISIT SITES (n=116)

Applicable to all 4 treatments

Considerable variation exists in the habitat variables for all 4 treatment types in this data set. The stem-density measures show extreme ranges [9]of values and highly skewed[10] frequency distributions. With such highly skewed distributions, the mean, or average, is subject to distortion since it is sensitive to extreme values. The value of the mean is pulled in the direction of the tail. For example, the mean number of aspen sprouts in 4-wire treatment is 1900/ha, and the median is 849/ha. The range, however is 42/ha to 11,883/ha. The mean is being "pulled" to the right, in the direction of the tail, by the extreme value of 11,883 sprouts/ha. The median, 1st and 3rd quartiles further describe the distribution of the variables and should be consulted in addition to the mean. Either median or mean value is used in the following sections. The reader is encouraged to refer to all 7 statistics for each variable.

Sample size was reduced in all 4 treatments for the following three variables: # aspen standing-dead unknown structural class, # aspen down-dead unknown structural class and height of aspen sprout-sapling average. Crews in 1999 and 2000 did not separate these measures as did crews in 2001. Thus, they were treated as separate variables. Differences in sample size for other variables reflect missing data.

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[4] 14.147 was used for 30 m plots, 56.5 for 15 m plots and 112.9 for one-half 15 m plots.

[5] One hectare=2.47 acres.

[6] **Mean:** the arithmetic average; **First Quartile:** the observed value for which 25% of the data fall below and 75% fall above when the data are ranked from lowest to highest; **Median**: the observed value for which 50% of the data fall below and 50% fall above when the data are ranked from lowest to highest; **Third Quartile:** the value for which 75% of the data fall below and 25% fall above when the data are ranked from lowest to highest; **Standard Deviation (SD)**: a statistic which measures the spread or variability in the data, i.e. the higher the standard deviation, the more spread out from the mean are the data; **Minimum:** the value of the minimum datum; **Maximum**: the value of the maximum datum.

[7] "Frequency of occurrence" is the number of observations (usually stands) in a given category.

[8] Categorical or qualitative variables are not measurements per se, but classifications into different categories represented by a number code.e.g. hair color, presence/absence, aspen vigor.

[9] The *range* is the difference between the maximum and minimum measurements of the data set for a variable.

[10] Skewed distributions have long tails in either direction, as opposed to the Normal distribution which is roughly mound-shaped and symmetrical.

Additionally, crews in 1999 and 2000 lumped aspen vigor into one class-adult- versus classes B and C as described by Tatum (Appendix 2). Thus, results of vigor classes B and C are from 2001, and results of vigor adults are from 1999 and 2000

A. Cages, condos, tubes (n=21)

Fourteen stem-density measures exhibited strongly right-skewed frequency distributions[11] and considerable range of values. The median value for the number of aspen sprouts/saplings was 538/ha[12] and 226/ha for conifers (Table 1). Relative vigor of aspen sprouts/saplings was evaluated using criteria developed by Tatum. Aspen sprouts/saplings were in the "declining" to "dead" or "absent" conditions in 38 % of sites. Twenty-four percent were in "stable" condition and 38% were in "mixed" condition (Appendix 4). Two measures of height were made for aspen sprouts/saplings: lower and upper ends of their height-range. Mean height for the lower end was 16 cm and for the upper end, 107 cm, see Table 1.[13] Ninety-three percent of stands showed evidence of historic browse by herbivores to the aspen sprouts/saplings layer, and 79% showed evidence of browse in the current year (Appendix 4).

Eighty-one percent of sites had no live sub-dominant aspen layer. The median value for the sub-dominant conifer layer was 99/ha, and was present in 76% of sites. Relative vigor for the sub-dominant aspen layer (Vigor B) was "absent" in 93 % of stands and "declining" in 3% for 14 sites surveyed in 2001, Appendix 4.

Vigor classes "B" and "C' were lumped into "Vigor Adults" for sites surveyed in 1999 and 2000. Fourteen percent of sites were in the "mixed" condition, 14% were "declining", 43% were "decadent", and 29% were in the "dead" condition (Appendix 4).

Fifty-seven percent of sites had no live co-dominant aspen layer. The median value for the conifer co-dominant layer was 42/ha, with 62% of sites having this layer. Relative vigor of Class C for 14 sites was as follows: "absent" in 79% of sites, "decadent" in 7% and "dead" in 14% Appendix 4).

The median value for the number of conifer dominants was 14/ha. On average, canopy cover by conifer was roughly 10X that of aspen. Average height of conifer co-dominant was roughly 3X that of aspen co-dominant, 16 m and 5 m, respectively. Height of conifer dominants averaged approximately 29 m. The mean amount of stand lost in this treatment was 86% Table 1.

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[11] *# aspen down-dead, sprout-sapling* had no observations, thus no distribution.

[12] Number of aspen sprout-sapling/ha was based on total number of aspen within the plot, both inside and outside of cages.

[13] Height of aspen sprout/saplings are for those outside of cages. Appendix 12 contains data for heights within cages.

Table 1
Descriptive statistics for 26 variables, cages, condos, tubes n=21

Variable	Sample Size	Mean	Standard Deviation	1st Quartile	Median	3rd Quartile	Minimum	Maximum
# Aspen sprout-sapling/ha	21	1679.5	3942.3	282.9	537.6	962.0	0.0	18221.3
# Aspen sub-dominant/ha	21	5.4	13.8	0.0	0.0	0.0	0.0	56.6
# Aspen co-dominant/ha	21	39.1	89.5	0.0	0.0	28.3	0.0	396.1
# Aspen standing-dead, sprout-sapling/ha	14	62.7	143.3	0.0	7.1	24.8	0.0	509.3
# Aspen standing-dead, sub-dom/ha	14	14.1	23.5	0.0	0.0	14.1	0.0	56.6
# Aspen standing-dead, unknown structural class/ha	7	20.2	25.6	0.0	14.1	35.4	0.0	56.6
# Aspen standing-dead, co-dom/ha	14	3.0	8.2	0.0	0.0	0.0	0.0	28.3
# Aspen down-dead, sprout-sapling/ha	14	0.0	0.0	0.0	0.0	0.0	0.0	0.0
# Aspen down-dead, sub-dom/ha	14	27.3	59.9	0.0	7.1	14.1	0.0	226.4
# Aspen down-dead, co-dom/ha	14	29.3	89.9	0.0	0.0	10.6	0.0	339.5
# Aspen down-dead, unknown structural class/ha	7	109.1	162.3	14.1	42.4	120.2	0.0	452.7
# Conifer sprout-sapling/ha	21	557.1	937.8	56.6	226.4	565.9	0.0	4074.3
# Conifer sub-dominant/ha	21	272.8	460.0	14.1	99.0	481.0	0.0	2037.2
# Conifer co-dominant/ha	21	64.0	78.0	0.0	42.4	99.0	0.0	297.1
# Conifer dominant/ha	21	88.3	137.8	0.0	14.1	99.0	0.0	509.3
Aspen canopy cover (%)	21	4.3	9.2	0.0	0.0	3.0	0.0	29.0
Conifer canopy cover (%)	21	41.4	20.5	28.2	39.0	58.6	3.0	78.6
Height of aspen sprout-sapling, average (cm)	5	40.0	17.3	40.0	50.0	50.0	10.0	50.0
Height of aspen sprout-sapling, low end (cm)	12	15.8	11.9	6.3	16.0	20.8	1.0	40.0
Height of aspen sprout-sapling, high end (cm)	13	107.4	75.2	40.0	80.0	190.0	22.0	200.0
Height of aspen, co-dominant (m)	14	4.9	5.7	0.0	4.2	7.0	0.0	19.1
Height of conifer, sub-dominant (m)	9	11.0	4.0	9.0	9.8	12.8	5.7	18.0
Height of conifer, co-dominant (m)	18	16.2	3.6	13.5	16.2	18.8	10.5	22.4
Height of conifer, dominant (m)	17	28.6	5.2	25.5	27.8	30.0	20.0	41.8
Amount of Stand Lost (%)	19	86	20.1	87.5	90	98.5	20	100
Slope Gradient (%)	20	11.1	11.9	4	8	14.2	0	54

B. 4-wire fence (n=28)

The median value for the number of aspen sprouts/saplings was 849/ha and 163/ha for conifers (Table 2). . Three percent of aspen sites had aspen sprout/saplings in "stable" condition, 43% in "mixed", 29% in "declining", and 25% in "decadent" condition for vigor class A (Appendix 6). Mean aspen-sprout-height for the lower end was 15cm and for the upper end, 73cm (Table 2). One-hundred percent of stands showed evidence of historic browse by herbivores to the aspen sprouts/saplings layer, and 60% showed evidence of browse in the current year (Appendix 6).

Seventy-five percent of sites had no live sub-dominant aspen layer. The median value for the sub-dominant conifer layer was 28/ha, and was present in 57% of sites. Relative vigor for the sub-dominant aspen layer (Vigor B) was "absent" in 73% of stands, "declining" in 9%, "decadent" in 9%, and "stable" in 9% for 11 sites surveyed in 2001 (Appendix 6). Adults vigor for 17 sites surveyed in 1999 and 2000 were as follows: 18% "mixed", 29% "declining", 29% "decadent", and 24% "dead" (Appendix 6).

The median value of live co-dominant aspen was 42/ha. The median value for the co-dominant conifer layer was 21/ha (Table 2). Relative vigor, class C, for 11 sites was "absent" in 27% of sites, "decadent" in 46%, "declining" in 18%, and "dead" in 9% (Appendix 6).

The median value for the number of conifer dominants was 35/ha. Mean canopy cover of conifers was roughly 4.5X that of aspen. Average height of conifer co-dominants was twice that of aspen co-dominants, 16 m and 7 m, respectively. Height of conifer dominants averaged 26 m. Standing-dead, co-dominant aspen were present in 55% of sites surveyed in 2001. The mean amount of stand lost in this treatment was 82% (Table 2).

Table2
Descriptive statistics for 26 variables, 4-wire fence (n=28)

Variable	Sample Size	Mean	Standard Deviation	1st Quartile	Median	3rd Quartile	Minimum	Maximum
# Aspen sprout-sapling/ha	28	1900.8	2427.0	473.9	848.8	2603.0	42.4	11883.5
# Aspen sub-dominant/ha	28	49.0	200.9	0.0	0.0	3.5	0.0	1061.0
# Aspen co-dominant/ha	28	93.5	122.2	14.1	42.4	155.6	0.0	452.7
# Aspen standing-dead, sprout-sapling/ha	11	892.5	1635.1	92.0	169.8	516.4	28.3	5206.1
# Aspen standing-dead, sub-dom/ha	11	7.7	18.3	0.0	0.0	0.0	0.0	56.6
# Aspen standing-dead, unknown structural class/ha	17	58.3	107.1	0.0	0.0	70.7	0.0	396.1
# Aspen standing-dead, co-dom/ha	11	20.6	33.7	0.0	14.1	21.2	0.0	113.2
# Aspen down-dead, sprout-sapling/ha	11	1.3	4.3	0.0	0.0	0.0	0.0	14.1
# Aspen down-dead, sub-dom/ha	11	11.6	16.5	0.0	0.0	28.3	0.0	42.4
# Aspen down-dead, co-dom/ha	11	16.7	28.9	0.0	0.0	21.2	0.0	84.9
# Aspen down-dead, unknown structural class/ha	17	118.2	160.0	0.0	42.4	169.8	0.0	565.9
# Conifer sprout-sapling/ha	28	582.6	939.3	0.0	162.7	767.5	0.0	4357.3
# Conifer sub-dominant/ha	28	79.3	122.1	0.0	28.3	113.2	0.0	396.1
# Conifer co-dominant/ha	28	60.1	88.9	0.0	21.2	77.8	0.0	339.5
# Conifer dominant/ha	28	57.6	75.1	0.0	35.4	63.7	0.0	268.8
Aspen canopy cover (%)	26	7.4	9.5	2.3	5.0	7.8	0.0	35.0
Conifer canopy cover (%)	28	33.3	17.4	20.3	35.0	41.0	0.0	69.0
Height of aspen sprout-sapling, average (cm)	12	28.3	22.5	18.8	27.5	35.0	0.0	75.0
Height of aspen sprout-sapling, low end (cm)	15	14.6	12.2	7.5	10.0	15.0	4.0	40.0
Height of aspen sprout-sapling, high end (cm)	15	73.2	56.0	30.0	50.0	95.0	15.0	200.0
Height of aspen, co-dominant (m)	16	7.4	6.9	2.4	5.2	12.0	0.0	24.0
Height of conifer, sub-dominant (m)	4	10.2	1.5	9.4	10.3	11.1	8.4	11.9
Height of conifer, co-dominant (m)	16	15.6	3.5	14.5	16.0	17.3	10.0	24.0
Height of conifer, dominant (m)	26	26.0	7.3	20.0	25.0	30.0	15.7	46.5
Amount of Stand Lost (%)	22	82.4	17.5	75.0	90.0	95.0	40.0	100.0
Slope Gradient (%)	28	13.8	13.1	7.8	10.0	15.0	0.0	70.0

C. Big-game fence (n=19)

The median value for the number of aspen sprouts/saplings was 2264/ha and 255/ha for conifers (Table 3). . Twenty-eight percent of aspen sites had aspen sprout/saplings in "vigorous" condition, 33% in "stable", 17% in "mixed", 17% in "declining", and 5% in "dead" condition for vigor class A (Appendix 8). Mean aspen-sprout-height for the lower end was 15cm and for the upper end, 103cm (Table 3). Ninety-four percent of stands showed evidence of historic browse by herbivores to the aspen sprouts/saplings layer, and 21% showed evidence of browse in the current year (Appendix 8). Some of the big game fences were installed immediately preceding surveys, thus observed herbivory likely occurred prior to the installation of the exclosure.

The median value for sub-dominant aspen was 14/ha. The median value for the sub-dominant conifer layer was 156/ha (Table 3). Relative vigor of the sub-dominant aspen layer (Vigor B) was "absent" in 58% of stands, "declining" in 14%, "decadent" in 7%, "mixed" in 14%, and "vigorous" in 7% for 14 sites surveyed in 2001 (Appendix 8).

The median value of live co-dominant aspen was 14/ha, and 28/ha for the co-dominant conifer layer. Average height of the co-dominant layer was 17m for conifers and 11m for aspen (Table 3). Relative vigor Class C, for 14 sites was as follows: "stable" and "declining" 29%, "mixed" 21%, and "vigorous", "declining", "dead" 7% (Appendix 8).

The median value for the number of conifer dominants was 57/ha. Mean canopy cover of conifers was roughly 4X that of aspen,30% and 8%, respectively. Height of the dominant conifer layer averaged 24 m. Standing-dead, co-dominant aspen were present in only 4 of 15 sites surveyed in 2001. The median value for amount of stand lost was 70% (Table 3).

Table 3
Descriptive statistics for 26 variables, big-game fence (n=19)

Variable	Sample Size	Mean	Standard Deviation	1st Quartile	Median	3rd Quartile	Minimum	Maximum
# Aspen sprout-sapling/ha	19	5722.8	10278.8	587.1	2263.5	4746.3	0.0	43572.8
# Aspen sub-dominant/ha	19	102.0	301.2	0.0	14.1	49.5	0.0	1329.8
# Aspen co-dominant/ha	19	47.7	78.8	0.0	14.1	42.4	0.0	325.4
# Aspen standing-dead, sprout-sapling/ha	15	2031.5	4750.5	99.0	169.8	1089.3	0.0	17542.3
# Aspen standing-dead, sub-dom/ha	15	95.3	154.9	0.0	14.1	106.1	0.0	551.7
# Aspen standing-dead, unknown structural class/ha	4	3.5	7.1	0.0	0.0	3.5	0.0	14.1
# Aspen standing-dead, co-dom/ha	15	5.7	10.4	0.0	0.0	7.1	0.0	28.3
# Aspen down-dead, sprout-sapling/ha	15	133.9	465.3	0.0	0.0	14.1	0.0	1810.8
# Aspen down-dead, sub-dom/ha	15	17.0	19.4	0.0	14.1	28.3	0.0	56.6
# Aspen down-dead, co-dom/ha	15	17.0	30.8	0.0	0.0	21.2	0.0	113.2
# Aspen down-dead, unknown structural class/ha	4	53.1	106.1	0.0	0.0	53.1	0.0	212.2
# Conifer sprout-sapling/ha	19	358.1	269.7	176.8	254.6	523.4	99.0	1131.8
# Conifer sub-dominant/ha	19	282.2	363.0	35.4	155.6	275.9	0.0	1216.6
# Conifer co-dominant/ha	19	39.5	50.3	0.0	28.3	42.4	0.0	198.1
# Conifer dominant/ha	19	60.3	69.1	7.1	56.6	77.8	0.0	226.4
Aspen canopy cover (%)	19	7.7	8.4	1.9	6.0	10.0	0.0	36.6
Conifer canopy cover (%)	19	30.3	16.1	21.3	27.6	40.3	6.4	66.4
Height of aspen sprout-sapling, average (cm)	3	46.7	15.3	40.0	50.0	55.0	30.0	60.0
Height of aspen sprout-sapling, low end (cm)	15	15.1	10.1	8.0	10.0	26.0	4.0	31.0
Height of aspen sprout-sapling, high end (cm)	14	103.1	62.2	50.0	90.0	145.0	40.0	200.0
Height of aspen, co-dominant (m)	16	11.4	7.5	7.6	11.0	16.6	0.0	23.6
Height of conifer, sub-dominant (m)	4	12.8	5.5	9.8	13.3	16.3	6.1	18.6
Height of conifer, co-dominant (m)	17	16.5	4.3	14.2	16.0	18.9	8.5	22.3
Height of conifer, dominant (m)	18	24.1	6.9	19.4	24.1	27.4	14.0	40.0
Amount of Stand Lost (%)	18	68.6	26.4	52.5	70.0	88.8	0.0	100.0
Slope Gradient (%)	19	7.6	11.3	1.5	4.0	8.5	0.0	50.0

D. Pre-treatment (n=48)

The median value for the number of aspen sprouts/saplings was 1528/ha and 205/ha for conifers (Table 4). . Twenty-five percent of aspen sites had aspen sprout/saplings in "absent", "decadent" or "dead" condition. One site was classified as "vigorous", 8% in "stable", 21% in "mixed", and 44% in "declining" condition (Appendix 10). Mean aspen-sprout-height for the lower end was 16 cm and for the upper end, 81cm (Table 4). Seventy-three percent of stands showed evidence of historic browse by herbivores to the aspen sprouts/saplings layer, and 56% showed evidence of browse in the current year (Appendix 10).

Seventy-nine percent of pre-treatment sites had no sub-dominant aspen layer. The median value for the remaining 10 sites was 149/ha. The median value for the sub-dominant conifer layer was 99/ha. Out of 10 sites surveyed in 2001, relative vigor for the sub-dominant aspen layer (Vigor B) was: "absent" in 3 stands, "declining" in 4, "vigorous" in 1, and "stable" in 3. Adults vigor for 38 sites surveyed in 1999 and 2000 was: "absent" in 1 site, "declining" in 5, "decadent" in 23, "dead" in 6, and "mixed" in 3 (Appendix 10).

The median value of live co-dominant aspen was 78/ha, and for co-dominant conifer the median was 14/ha. Relative vigor (class C) for 10 sites surveyed in 2001 was as follows, "absent" in1,"declining" in 4, "decadent" and "dead" each with 1 site, "stable" in1 and "mixed" in 2 (Appendix 10). Average height of the co-dominant layer was 17m for conifers and 11m for aspen (Table 4).

The mean number of conifer dominants was 106/ha. Mean canopy cover of conifers was 30%, and for aspen it was14%. Height of the dominant conifer layer averaged 27 m. The median value for number of standing-dead aspen, unknown structural class was 28/ha. The median value for amount of stand lost was 90% (Table 10).

E. Tree Age

Tree ages for aspen and conifer were summarized across stands by structural class. At the time of this writing, personnel were unavailable to determine age of aspen from cores collected in 2001. When that data is collated, an addendum report will be generated and presented to Prairie City Ranger District.

Average age of sub-dominant and co-dominant conifer was 62 years and 77 years, respectively. The median age for dominant conifers was 100 years (Table 5). Average age of co-dominant aspen (from 1999 and 2000) was 115 years (Table 6). Sub-dominant aspen were not aged (see methods section).

Table 4
Descriptive statistics for 26 variables, pre-treatment (n=48)

Variable	Sample Size	Mean	Standard Deviation	1st Quartile	Median	3rd Quartile	Minimum	Maximum
# Aspen sprout-sapling/ha	48	2574.0	3604.5	378.4	1527.9	3059.3	0.0	17881.8
# Aspen sub-dominant/ha	48	53.9	175.7	0.0	0.0	0.0	0.0	1032.7
# Aspen co-dominant/ha	48	90.5	77.1	38.9	77.8	155.6	0.0	325.4
# Aspen standing-dead, sprout-sapling/ha	10	430.1	439.7	81.3	254.6	707.4	14.1	1287.4
# Aspen standing-dead, sub-dom/ha	10	41.0	60.6	0.0	7.1	70.7	0.0	169.8
# Aspen standing-dead, unknown structural class/ha	38	70.0	127.9	0.0	28.3	106.1	0.0	735.6
# Aspen standing-dead, co-dom/ha	10	22.6	31.4	0.0	7.1	28.3	0.0	84.9
# Aspen down-dead, sprout-sapling/ha	10	0.0	0.0	0.0	0.0	0.0	0.0	0.0
# Aspen down-dead, sub-dom/ha	10	21.2	19.2	3.5	21.2	28.3	0.0	56.6
# Aspen down-dead, co-dom/ha	10	22.6	16.6	14.1	28.3	28.3	0.0	56.6
# Aspen down-dead, unknown structural class/ha	38	174.6	256.9	0.0	106.1	226.4	0.0	1414.7
# Conifer sprout-sapling/ha	48	492.2	762.8	53.1	205.1	587.1	0.0	4244.1
# Conifer sub-dominant/ha	48	255.8	376.7	10.6	99.0	339.5	0.0	1924.0
# Conifer co-dominant/ha	48	53.9	102.5	0.0	14.1	56.6	0.0	565.9
# Conifer dominant/ha	48	106.4	271.7	0.0	42.4	116.7	0.0	1867.4
Aspen canopy cover (%)	45	14.3	15.8	3.0	10.0	19.0	0.0	72.0
Conifer canopy cover (%)	45	29.2	18.1	21.0	28.0	41.0	0.0	74.0
Height of aspen sprout-sapling, average (cm)	23	75.2	61.0	30.0	60.0	100.0	0.0	250.0
Height of aspen sprout-sapling, low end (cm)	17	15.5	12.1	10.0	10.0	20.0	1.0	50.0
Height of aspen sprout-sapling, high end (cm)	17	80.6	57.8	35.0	60.0	100.0	20.0	200.0
Height of aspen, co-dominant (m)	23	11.2	7.9	4.0	12.0	16.5	0.0	22.0
Height of conifer, sub-dominant (m)	5	10.2	3.3	8.5	9.0	13.6	6.1	13.7
Height of conifer, co-dominant (m)	28	16.5	3.8	14.0	16.0	18.0	10.0	25.8
Height of conifer, dominant (m)	38	26.7	6.8	22.0	25.2	30.4	12.0	40.0
Amount of Stand Lost (%)	37	80.5	20.6	75	90	95	20	100
Slope Gradient (%)	45	13.6	11.8	10	10	15	1	70

Table 5
Age of conifer across stands by structural class, 1999-2001.

	Sample Size (# of trees)	Mean	Standard Deviation	1st Quartile	Median	3rd Quartile	Minimum	Maximum
Age of Sub-dom Conifer	124	62.1	25.1	44	64	79	12	134
Age of Co-dom Conifer	188	77.3	22.6	59	80	94	25	149
Age of Dominant Conifer	286	119.3	68.8	77	100	134	31	405

Table 6
Age of co-dominant aspen across stands, 1999-2000.

	Sample Size (# of trees)	Mean	Standard Deviation	1st Quartile	Median	3rd Quartile	Minimum	Maximum
Age o-dom Aspen (1999 and 2000)	149	114.9	26.7	110	118	129	11	174

RE-VISIT SITES (n=41)

Plot-centers were not marked during the initial inventory, nor were GPS coordinates recorded, thus these are not true "re-measure" plots. However, due to the large plot size relative to the small size of aspen stands, comparative data presented in Tables 7 and 8, likely reflect general changes in stem density. Data from sites 511 and 517 were not compared with previous years' data because stand identification number and treatment type did not match. The re-visit data set was separated into two primary groups for presentation: group 1-treatment[14] present in 2001 was in place at the time of the initial survey, group 2-treatment present in 2001 was different than at the time of the initial survey.

Group 1 (n=21[15])

On average, numbers of aspen sprouts/ha decreased in all treatment types except big game fence, which increased. The average number of conifer sprouts/ha decreased in all treatment types except 4-wire which increased (Table 7).

Group 2 sites (n=20)

The average number of aspen sprouts/ha increased in big game treatment type, but decreased in 4-wire and cages treatment types. The average number of conifer sprouts/ha decreased in all 3 treatment types (Table 8).

[14] "Treatment" includes big game fence, cages/condos/tubes, 4-wire fence, and no treatment.
[15] Sites 36a and b, 96a and b were counted as one site each for sample size computations.

Table 7
Comparative data for Group 1-treatment present in 2001 was in place at the time of the initial survey (n=21)

Site	Treatment	Year treatment implemented	# Aspen sprouts/ha in year treatment implemented	# Aspen sprouts/ha in 2001	# Aspen sub-dom/ha in year treatment implemented	# Aspen sub-dom/ha in 2001	# Conifer sprouts/ha in year treatment implemented	# Conifer sprouts/ha in 2001
pc505	4-wire, cages, aspencut, no burn	1999	57	99	0	14	0	4287
pc524	4-wire, cages, cut, no burn	1999	2829	1188	14	0	141	198
pc501	4-wire, cages, no cut, no burn	1999	42	0	0	0	0	240
pc502	4-wire, cages, no cut, no burn	1999	283	57	0	0	0	170
pc124	4-wire, cages, cut, burn	2000	849	1245	0	0	0	71
pc123	4-wire, cages, cut, no burn	2000	1584	212	0	0	0	821
pc537	4-wire, cages, no cut, no burn	2000	99	127	0	0	0	0
	Average		821	418	2	2	20	827
pc508	BG no cut, no burn	1999	5659	17402	14	0	297	113
pc506	BG, cut, no burn	1999	2264	1471	0	0	382	42
pc539	BG, cut, no burn	2000	340	1754	0	0	0	212
	Average		2754	6876	5	0	226	123
pc527	cages only	1999	18221	283	0	0	396	113
pc531	cages only	1999	283	141	0	0	28	269
	Average		9252	212	0	0	212	191
pc32	No treatment	1999	3395	481	0	0	340	14
pc33	No treatment	1999	679	226		0		0
pc34	No treatment	2000	6791	1825	0	0	311	85
pc132	No treatment	2000	0	226	0	57	57	622
pc95a	No treatment	2000	57	622	0	0	99	57
pc95b	No treatment	2000	0	113	0	0	57	962
pc28	No treatment	2000	4188	5843	113	0	566	57
pc29	No treatment	2000	792	594	170	113	226	424
pc96 (a)	No treatment	2000	0	0	0	0	283	57
pc96 (b)	(2 plots in 2000, 1 plot in 2001)	2000	0		0		1132	
	Average		1590	1103	31	19	341	253

Table 8
Comparative data for Group 2-treatment present in 2001 was different than at the time of the initial survey (n=20)

Site	Treatment	Year treatment implemented	# Aspen sprouts/ha in year treatment	# Aspen sprouts/ha in 2001	# Aspen sub-dom/ha in year treatment	# Aspen sub-dom/ha in 2001	# Conifer sprouts/ha in year treatment	# Conifer sprouts/ha in 2001
pc510	BG cut, burn	1999	3367	5164	0	0	424	0
pc27	BG, cut, no burn	1999	7074	7668	0	0	113	127
	Average		5220	6416	0	0	269	64
pc07	cages only	2000	2425	1867	0	0	1415	849
pc14	cages only	1999	113	0	0	0	0	453
pc15	cages, condo	1999	1245	0	0	0	2150	113
	Average		1261	622	0	0	1188	472
pc31	4-wire, cages, no cut, no burn	2000	5659	2136	0	0	113	28
pc16	4-wire, cages	1999	1471	1386	0	0	57	523
pc17	4-wire, cages	1999	453	42	0	0	4244	594
pc18	4-wire, cages	1999	1698	2334	0	0	0	552
pc10	4-wire, cages, cut, no burn	1999	2603	1174	0	0	42	42
pc11	4-wire, cages, cut, no burn	1999	368	85	0	0	0	170
pc19	4-wire, cages, cut, no burn	1999	382	156	0	0	255	453
pc25	4-wire, cages, cut, no burn	1999	2264	2830	0	0	0	113
pc509	4-wire, cages, moved trough	1999	42	28	57	0	113	28
pc38	4-wire, cages, no cut, burned	1999	3395	495		0		0
pc38b	4-wire, cages, no cut, burned	1999	127	439	0	0	0	99
pc13	4-wire, cages, no cut, no burn	1999	6338	4131	0	0	71	622
pc26	4-wire, cages, no cut, no burn	1999	2094	4131	0	0	42	113
pc518	4-wire, cages, no cut, no burn	1999	1698	141	0	0	113	637
pc36a	4-wire, cages, moved trough	1999	340	424	0	0	453	212
pc36b	4-wire, cages, moved trough	1999		736		0		198
	Average		1929	1292	4	0	393	274

SUMMARY

A total of 116 aspen sites were sampled on Prairie City Ranger District, Malheur National Forest from 1999-2001. Forty-eight stands were pre-treatment, 28 were 4-wire, 21 were cages/tubes, and 19 were big game. The median number of aspen sprouts was: 538/ha for cages/tubes, 849/ha for 4-wire, 2264/ha for big game, and 1528/ha for pre-treatment. Conifer canopy cover was at least twice that of aspen in all 4 treatment types. The dominant conifer layer overtopped the aspen co-dominant layer by at least 13 m in all treatment types. The median value for estimated loss of stand area was 70% in big game sites, and 90% in the other 3 treatment types. Average age of sub-dominant and co-dominant conifer was 62 years and 77 years, respectively. The median age for dominant conifers was 100 years. Average age of co-dominant aspen (from 1999 and 2000) was 115 years All re-visit sites except those in big game treatment showed decreases in average number of aspen sprouts/ha.

Results from this series of studies are valid for the specific sites sampled. Extrapolation to other aspen stands or inferences about effectiveness of treatments is questionable since these studies were not statistically designed. These were pilot studies designed to provide a better perspective on the problems of aspen stands in the Blue Mountains. Data gathered was to be used to design statistically rigorous research projects that would provide managers with information to improve aspen management. Funding was not available so the projects were not developed.

DISCUSSION

Aspen is a relatively short-lived tree in the Blue Mountains,100-120 years, (Crowe, 1996) and relies on suckering (sprouting from the roots) to persist. Potential regeneration problems are likely in mature to over-mature stands with fewer than 1235 suckers/ha (Brown, 1996). Determining the most efficacious and cost-effective treatment(s) to rejuvenate aspen within the landscape, not just at the individual stand-level, was a primary objective of this project. Typical treatments in the Blue Mountains (separately or in aggregate) include conifer-thinning, removal of mature aspen, and burning, accompanied by fencing. Treatments are generally focused on the aspen stand itself, an appropriate and necessary methodology to ensure survival of individual stands. Long-term, large-scale rejuvenation however, should also involve assessment of surrounding areas where historic land management practices have altered the historic vegetation/forage community.

Appendix 1.

Site #:___________ **Date:**____________

Vigor:___________ Location:_____________

Landform:____________ 1 seep, 2 non-seep but sub-drainage, 3 riparian, 4 meadow, 5 upland

Treatment____________

% Lost______________

Paired Plot___________

Density	Sprout/sapling		Sub		Co-dom. Overstory		Dom. Overstory		Total
Aspen live									
Standing dead									
Down dead									
Conifer spp.									
Conifer spp.									

						Total
Aspen Canopy Cover						
Conifer Canopy Cover						

Aspen height — Co-dom. Overstory ____________________ Dominant Overstory ____________________

Conifer height ____________________ ______________________
Aspen sprout/sapling height (range) ______________ Browsed (y/n) ______current years______
# of aspen cored _______ Could not core due to rot _______

DBH Aspen ______ ______ ______ ______ ______
DBH Dominant Conifer ______ ______ ______ ______ ______
DBH Sub/co-dom. Conifer ______ ______ ______ ______ ______
Conifers cored inside aspen stand _________ # cored sub_____co_____dom______
Conifers cored at edge of aspen stand _________ # cored sub______co______dom_____

		Cover Class		
Primary Shrub	____________________	__________	1	<1 %
Secondary Shrub	____________________	__________	2	1-5 %
Primary Grass	____________________	__________	3	5-15 %
Secondary Grass	____________________	__________	4	15-25 %
Primary Forb	____________________	__________	5	25-50 %
Secondary Forb	____________________	__________	6	50-75 %
			7	75- 95%
			8	100%

Slope ___________
Slope' ___________ 1crest 2mid 3toe
Aspect ___________
Elevation ___________
Micro-relief ___________ 1convex 2concave 3flat
COMMENTS:

Appendix 2.

Aspen Stand Vigor Classification

In an attempt to classify stand structures found in various hardwood stands throughout the Districts, Mike Tatum designed the following system. It identifies several characteristics of stands in simple yet reasonably accurate terms:

	"A"	**"B"**	**"C"**
Structural Layer:	Understory	Midstory	Overstory
Typical Age:	0-25	25-75	75-125+
Age Class:	Sprouts/Juvenile	Immature/Early Mature	Late/Over Mature
Size Group:	Sprouts/Sapling	Poles/Large	Large+
Vigor Groups:	0 layer absent	0 layer absent	0 layer absent
	1 vigorous	1 vigorous	1 vigorous
	2 stable	2 stable	2 stable
	3 mixed cond.	3 mixed cond.	3 mixed cond.
	4 declining	4 declining	4 declining
	5 decadent	5 decadent	5 decadent
	6 dead	6 dead	6 dead

Each site can be characterized with the use of seven characters to depict the presence and condition of any one layer. These available characters give 343 combinations to accurately describe structure. For example: A stand with a nearly dead understory, a middlestory with some good and some poor condition individuals and an overstory of fair condition would be classified as: "A4B3C2".

Definitions for vigor groups:

0 = **Layer absent** = No individuals of this structure are present, common sense applies: if you have a clump of 3 aspen and there are three sprouts, then this layer does exist, the same three sprouts contained within a 3 acre aspen stand would not count.

1 = **Vigorous** = No evidence of permanent disease (conks), foliage disease may be present but not causing long term damage, bark is healthy (not seriously damaged), evidence shows very good annual leader/height growth, minor browsing/hedging.

2 = **Stable** = The layer appears to be free and clear to grow, only minor stem or leaf disease, browsing or hedging may be checking annual growth, other minor physical damage may have occurred, only occasional cavity excavation. Growth "good-fair".

3 = **Mixed condition** = A significant portion of the individuals in this structural layer meet condition 1 or 2, and a significant portion meet conditions 4-6.

4 = **Declining** = Shortening crown ratio's, lack of or short annual growth, cavity excavators beginning frequent excavations, disease conks present, heavy browsing/hedging with reduced sprouting, suppression or overtopping by other trees, or other physical damage causing serious injury. Occasional dead trees of this layer present. Growth "poor".

5 = **Decadent** = Nearly dead, frost cracks, broken or split tops, major portion of tree dead, many cavities from bird use, typically at least 80-90 years old at minimum. Dead trees common of same age. Growth "stopped".

6 = **Dead** = Dead.

Appendix 3. Site-specific data for aspen plots inventoried in 1999.

Site	Date	Treatment	Aspen sprout-sapling/ha	Aspen sub-dom/ha	Aspen co-dom/ha	Aspen standing-dead/ha, unknown structural class	Aspen down-dead/ha unknown structural class	Conifer sprout-sapling/ha
PC10	1999	pre-4wire,cages, con cut	2603	0	85	0	0	42
PC11	1999	pre-4wire, cages sub con cut	368	0	85	0	0	0
PC12	1999	NONE	0	0	85	170	14	42
PC13	1999	PRE 4WIRE CAGES	6338	0	57	0	85	71
PC14	1999	PRE CAGES	113	0	0	28	113	0
PC147	1999	CAGES	2264	57	396	57	453	226
PC15	1999	PRE CAGES	1245	0	57	0	283	2150
PC16	1999	PRE 4WIRE CAGES	1471	0	42	14	28	57
PC17	1999	PRE 4WIRE CAGES	453	0	28	85	311	4244
PC18	1999	PRE 4WIRE CAGES	1698	0	127	0	0	0
PC19	1999	PRE CAGES	382	0	42	42	0	255
PC24	1999	NONE	0	0	170	57	283	849
PC25	1999	pre-4wire,cages, con cut	2264	0	170	113	509	0
PC26	1999	PRE 4WIRE CAGES	2094	0	113	28	0	42
PC27	1999	pre-bgf,partial con cut	7074	0	57	28	226	113
PC32	1999	PRE-TREATMENT, NONE YET	3395	0	99	0	57	340
PC33	1999	PRE-TREATMENT, NONE YET	679	0	57	14	212	311
PC36	1999	NONE - HAS HAD COM. THINNING	340	0	212	85	255	453
PC38	1999	PRE 4WIRE CAGES past burn	3395	0	0	42	170	0
PC38B	1999	PRE-TREATMENT, CAGES	127	0	71	0	85	57
PC42	1999	CAGES	2999	0	113	0	42	14
PC48	1999	4-wire, cages, past logging	113	0	28	0	226	0
PC500	1999	4-wire,cages,some conifer cut	141	0	0	71	127	1146
PC501	1999	4-wire, cages	42	0	14	0	0	0
PC502	1999	4-wire, cages	283	0	85	0	0	0
PC505	1999	4-wire, cages	57	0	424	0	85	382

Appendix 3 cont.

Site	Date	Treatment	Aspen sprout-sapling/ha	Aspen sub-dom/ha	Aspen co-dom/ha	Aspen standing-dead/ha, unknown structural class	Aspen down-dead/ha unknown structural class	Conifer sprout-sapling/ha
PC506	1999	BGF SUB & CO. DOM CONIFER CUT	2264	14	42	14	212	297
PC508	1999	BGF	5659	57	325	0	0	113
PC509	1999	pre-4wire,cages, con cut	42	0	226	42	170	424
PC510	1999	pre-BGF,cut and burned	3367	0	0	0	113	651
PC511	1999	4-wire, cages	3961	0	240	0	42	71
PC515	1999	BGF AFTER BURN	11318	0	113	0	0	283
PC516	1999	4-wire	566	0	156	0	0	42
PC517	1999	4-wire, cages	849	0	156	0	0	113
PC518	1999	pre-trt	1698	14	99	156	71	141
PC520	1999	4-wire??past ct	2405	1061	57	396	566	679
PC521	1999	4-wire, cages, past ct	3395	0	240	113	170	113
PC522	1999	CAGES	4301	28	71	0	71	0
PC524	1999	4-wire, cages, most conifer cut	2829	0	99	113	0	396
PC525	1999	4-wire, cages	1981	0	184	42	184	1485
PC527	1999	CAGES	18221	0	113	14	28	28
PC531	1999	CAGES	283	0	57	14	0	0
PC9	1999	PRE CAGES	637	0	0	0	0	0

Appendix 3 cont.

Site	Conifer sub-dom/ha	Conifer co-dom/ha	Conifer dominant/ha	Aspen canopy cover (%)	Conifer canopy cover (%)	Aspen height sprout-sapling average (cm)	Conifer height co-dom (m) (average)	Conifer height dominant (m) (average)	Historic browse (%)	Current year browse (%)	Vigor A sprouts
PC10	14	57	71	35	26	100		35	100	100	3
PC11	0	0	0	0	0	60			0	0	4
PC12	0	85	226	0	74	30	16	25	100	100	0
PC13	382	42	42	1	24	60			0	0	4
PC14	0	156	113	13	37	30	13	25	70	70	5
PC147	622	0	509	19	39	50	13	30	100	100	4
PC15	42	0	28	19	27	50		40	70	70	3
PC16	0	0	141		38	150		35	0	0	4
PC17	57	57	127	46	28	20	18	25	100	100	4
PC18	0	0	71	7	22	150		40	0	0	4
PC19	71	0	71	16	9	100	15	20	70	70	5
PC24	283	0	283	4	52	100	10	18	70	70	0
PC25	0	0	0			250			0	0	4
PC26	0	0	0	72	0	150	17		0	0	3
PC27	0	0	113	28	30	0		40	70	70	3
PC32	566	0	0	13		0			70	70	4
PC33	57	14	71	6	33	100		30	70	70	4
PC36	0	14	0	3	5	100	18	35	0	0	4
PC38	42	14	28	40	5	0		22			3
PC38B	57	0	0	37	2	30			70	70	5
PC42	85	28	0	29	3	40	17		100	100	3
PC48	170	0	226	4	39	30		20	0	0	4
PC500	28	0	156	5	59	30		25	100	100	4
PC501	0	0	0		47	25		20	100	100	5

Appendix 3 cont.

Site	Conifer sub-dom/ha	Conifer co-dom/ha	Conifer dominant/ha	Aspen canopy cover (%)	Conifer canopy cover (%)	Aspen height sprout-sapling average (cm)	Conifer height co-dom (m) (average)	Conifer height dominant (m) (average)	Historic browse(%)	Current year browse (%)	Vigor A sprouts
PC502	0	0	0		51	25		20	100	100	3
PC505	0	0	170	34	35	50		20	100	100	5
PC506	57	42	0	12	10	30	15	30	0	0	2
PC508	0	0	226	16	43	60		25	70	70	2
PC509	99	42	42			20	18	25	100	100	5
PC510	57	57	0	33	8	80	16	22	70	70	2
PC511	0	156	42	0	38	75	16	30	100	100	4
PC515	283	0	113	8	28	50		40	70	70	1
PC516	85	184	85	6	49	50	10	35	70	70	5
PC517	28	42	28	35	18	30		30	100	100	3
PC518	170	42	198	0	61	50	15	30	0	0	3
PC520	396	57	0	3	5	0	16				3
PC521	396	113	113	0	35	25	16	30	0	0	3
PC522	127	99	42	6	21	50	14		100	100	5
PC524	113	340	0	6	35	0		25	70	70	3
PC525	382	0	42	8	69	0		40			4
PC527	170	170	0	29	39	10	20		?	?	3
PC531	0	0	141	0	66	50		25	70	70	4
PC9	0	0	269	43	41	100		25	100	100	2

Appendix 3 cont.

Site	Vigor adults	Landform	% Lost	% Slope	Position on slope	Aspect	Micro-relief
PC10	4	5	90	15	2	SE	2
PC11	4	1	60	10	2	SW	2
PC12	5	3	75	10	2	SW	2
PC13	5	3	?	10	2	SW	2
PC14	6	3	100	10	2	SE	2
PC147	3	3	?	15	2	W	2
PC15	5	3	95	10	2	SE	2
PC16	5	5	?				
PC17	5	5	?				
PC18	5	5	?	15	2	SE	3
PC19	5	5	85	15	2	SW	1
PC24	5	5	95	25	2	SE	2
PC25	5	2	?	10	2	SE	2
PC26	5	2	?	10	2	SE	2
PC27	5	5	80	20	2	E	1
PC32	4	4	40	5	2	E	2
PC33	5	3	70	10	2	NE	2
PC36	4	5	?	15	2	W	2
PC38	6	5	100	15	2	SE	2
PC38B	5	5	90	10	2	SE	2
PC42	6	5	75	15	2	SW	2
PC48	3	3	95	15	2	N	2
PC500	6	5	99	10	2	NW	1
PC501	6	3	95	10	2	SE	2
PC502	6	3	100	10	2	S	2
PC505	4	5	50	15	2	SE	1

Site	Vigor adults	Landform	% Lost	% Slope	Position on slope	Aspect	Micro-relief
PC506	4	2	?	15	2	NW	2
PC508	3	4	45	5	2	S	3
PC509	4	3	?	10	2	S	2
PC510	0	2	?	10	2	SW	2
PC511	4	3	?	10	2	SW	2
PC515	1	1	0	50	2	SW	1
PC516	5	5	?	25	2	SW	2
PC517	5	1	65	15	2	S	2
PC518	3	3	70	15	2	S	1
PC520	3	2	?	15	2	E	2
PC521	4	5	?	10	2	E	2
PC522	5	1	75	5	2	N	2
PC524	5	3	85	20	2	NE	2
PC525	3	2	?	5	2	N	3
PC527	4	3	?	10	2	SW	3
PC531	5	5	90	5	2	S	1
PC9	6	5	100	15	2	SW	2

Site	Comments
PC10	15 OUT OF 21 SUB CON. CUT
PC11	18 CAGES ON SITE
PC12	HEAVY CONIFER ENCROACHMENT RECOMMEND COMPLETE REMOVAL OF SAP/SUB CON. THEN BURN/FENCE SITE HEAVILY IMPACTED BY COWS
PC13	21 0F 448 SUCKERS IN CAGES DOESN'T DO IT JUSTICE NEEDS BG FENCE?? 7 CAGES
PC14	WAS HISTORICALLY A LONG STRINGER ALONG DRAINAGE, SUCKERS ONLY IN CAGES
PC147	NO CAGES IN PLOT
PC15	WAS HISTORICALLY A LONG STRINGER ALONG DRAINAGE, SUCKERS ONLY IN CAGES
PC16	
PC17	
PC18	PRE-TREATMENT DATA
PC19	8 CAGES 2 OF 3 SUCKERS WERE IN CAGES
PC24	COMMERCIAL THINNING OCCURRED IN THE PAST
PC25	8 CAGES
PC26	11 CAGES
PC27	I WOULD HAVE CUT ALL SAPLING PINE THE DRAINAGE BELOW IS ALL DEAD DOWN ASPEN THIS TREATMENT LOOKS LIKE IT WILL REALLY RESPOND . ALL ADULT TREES HAVE PARTIAL DEAD CROWNS
PC32	HEAVY COW USE
PC33	HEAVY COW USE
PC36	30+ SUB CON. CUT DISTINCT PATCH OF LARGE TALL ASPEN
PC38	ONLY EVIDENCE OF ONE ADULT ASPEN ON SITE-DEAD, FAIRLY HIGH NUMBER OF DOMINANT CONIFER. NEED BTO LOOK AT AGES
PC38B	STAND WAS ONCE LARGE BUT HAS BEEN REDUCED TO SEVERAL PARTIAL LIVE TREES, A LOT OF CO-DOM CON. NEED TO AGE TP SEE IF THEY OCCUR NATURALLY OR IF SITE IS STOCKED HIGHER THAN NORMAL & IS SHADING SITE
PC42	WAS PROBABLY ALWAYS A SMALL PATCH 41% OF SUCKERS OCCURRED IN CAGES
PC48	STAND WAS ONCE LARGE, THE DRAINAGE HAS A LOT OF DEAD DOWN ASPEN AND FEW SUCKERS, ALL SUCKERS OCCUR IN CAGES BECAUSE CAGES WERE PLACED OVER THEM
PC500	ALL SUCKERS IN 9 CAGES
PC501	18 CAGES, ALL ARE EMPTY EXCEPT 1
PC502	SUCKERS ONLY OCCUR IN CAGES, PROBABLY DUE TO CAGES PLACED AROUND SUCKERS=SELECTION
PC505	NEEDS MORE THAN JUST A FENCE AND CAGES, NEEDS SOME SILVICULTURAL TREATMENT

Site	Comments
PC506	SUCKERS LOOK GOOD
PC508	SUCKERS LOOK GOOD
PC509	ADULT ASPEN ARE DECADENT COULD CUT MORE TO GET SUCKER RELEASE, THREE PATCHES OF ASPEN IN TRTMNT, COULD CUT ONE TO COMPARE
PC510	100 CUT CON. STUMPS IN PLOT, 9 KILLED ASPEN
PC511	LOOKS LIKE EXCLOSURE HAS BEEN HERE AWHILE, HOW LONG? SUCKERS ARE STILL BEING BROWSED, ARE MULTI-STEMMED, DO NOT LOOK GREAT
PC515	
PC516	
PC517	A LOT OF DEER SIGN AND SOME ELK SIGN, SUCKERS BROWSED HEAVILY, NEEDS BG FENCE AND ASPEN CUT?? TREATMENT NOT WORKING, IFASPEN CUT WITHOUT BETTER PROTECTION STAND WOULD BE BROWSED TO EXTINCTION
PC518	SITE HAS HAD CO-DOM CONIFER LOGGED OUT IN PAST, 7 CUT IN PLOT, SUCKERS OUTSIDE CAGES HAVE BEEN BROWSED THIS YEAR AND IN PAST
PC520	SITE HAS FRESH CATTLE USE, DON'T KNOW IF THIS CAN BE CLASSED AS CATTLE EXCLOSURE
PC521	32 CAGES ON SITE
PC522	VERY TALL AND LARGE ADULT ASPEN, A LOT OF SUCKERS PRESENT BUT ONLY 6 CAGES ONLY 3% OF SUCKERS IN CAGES, A LOT OF SAPLING CONIFER, SITE NEEDS SILVICULTURE TREATMENT AND BG FENCE
PC524	HARD CALL IF THIS TREATMENT IS WORKING MIGHT WANT TO CUT SOME ASPEN AND USE BG FENCE HARD TO TELL IF RECRUITMENT IS ACTIVE OR PASSIVE
PC525	A LOT OF SMALL SUCKERS THAT WOULD REGEN TO TREES IF ALLOWED TO ESCAPE BROWSING, 21% OF SUCKERS IN CAGES. SITE HAS NICE, LARGE ADULT ASPEN
PC527	SUCKERS .3 TALL OUTSIDE CAGES AND 1.5 TALL INSIDE, 16% OF SUCKERS INSIDE CAGES, BG FENCE WOULD REALLY ALLOW A LOT OF REGEN TO OCCUR.
PC531	ALL SUCKERS IN CAGES
PC9	40 OF 45 SUCKERS OCCURRED IN CAGES 15 CAGES ON SITE

Appendix 3 cont.

Site	Date	Primary shrub	Cover class	Secondary shrub	Cover class	Primary grass	Cover class	Secondary grass	Cover class
PC10	1999					carex	2		
PC11	1999	snowberry	1	ribes	1	carex	2	orchard g.	1
PC12	1999	snowberry	1	ribes	1	many spikelets	1	k.blue	1
PC13	1999	rabbit brush	2			sitanion	1	B. marginatus	1
PC14	1999	ribes	2	snowberry	1				
PC147	1999	snowberry	2	ribes	1	carex	2		
PC15	1999	snowberry	2	ribes	1	sitanion	2		
PC16	1999	snowberry	2	ribes	2	carex	2		
PC17	1999	snowberry	2	ribes	2	carex	2		
PC18	1999	snowberry	2	ribes	2	carex	2		
PC19	1999	snowberry	2	service berry/r+D24ibes	1	carex	2	pine g.	2
PC24	1999	snowberry	3	service berry	1	carex	3		
PC25	1999	ribes	1			carex	3	pine g.	1
PC26	1999	rabbit brush	1	ribes/snowberry/rosa	1	carex	3	pine g.	2
PC27	1999	rhibes	2	snowberry	1	carex	3		
PC32	1999	snowberry	1			k.blue	2		
PC33	1999	snowberry	1			k.blue	2	brome	2
PC36	1999	snowberry	1	ribes	1	carex	2		
PC38	1999					carex	3	pine g/sitanion	1
PC38B	1999					carex	2	stipa?	1
PC42	1999					pine g.	2	carex	1
PC48	1999	ribes	1			brome	3	carex	2
PC500	1999	ribes	1			sitanion/pine g.	2	carex	2
PC501	1999	ribes	1			pine g.	2	sitanion	2
PC502	1999	rabbit brush	2	ribes	1	k.blue	2	sitanion/pine g.	2
PC505	1999	snowberry	1	ribes	1	carex	2	koleria	1
PC506	1999								

Appendix 3 cont.

Site	Primary forb	Cover class	Secondary forb	Cover class
PC10	arnica	2	strawberry	1
PC11	arnica	1	strawberry	1
PC12	arnica	2	dandelion	1
PC13	arnica	1	yarrow	1
PC14	yarrow	2	strawberry	2
PC147	arnica	1	oregon grape	1
PC15	yarrow	1	strawberry	1
PC16	yarrow	1	strawberry	1
PC17	yarrow	1	strawberry	1
PC18	yarrow	1	strawberry	1
PC19	oregon grape	1	galium	1
PC24	oregon grape	1	strawberry	1
PC25	arnica	1	strawberry	1
PC26	strawberry	1	yarrow	1
PC27	strawberry	2	lupine/yarrow/arnica	1
PC32	longleaf	2	strawberry	1
PC33	strawberry	2	longleaf	1
PC36	viola	2	oregon grape	2
PC38	arnica	2		
PC38B	strawberry	1	lupine/yarrow	1
PC42	oregon grape	1	arnica	1
PC48	strawberry/yarrow/galium	2		
PC500	yarrow	1	strawberry	1
PC501	strawberry	2	yarrow	1
PC502	oregon grape	1	strawberry	1
PC505	arnica	3	strawberry	1
PC506				

Appendix 4. Site-specific data for aspen plots inventoried in 2000.

Site	Date	Treatment	Aspen sprout-sapling/ha	Aspen sub-dom/ha	Aspen co-dom/ha	Aspen dominant/ha	Aspen standing-dead/ha, unknown structural class	Aspen down-dead/ha unknown structural class	Conifer sprout-sapling/ha
PC07	2000	Pre-trt	2425	0	57	0	0	0	1415
PC106	2000	Pre-trt	2829	0	113	0	0	57	962
PC117	2000	Cages	566	0	14	0	0	0	255
PC123	2000	4-wire w/cages	1584	0	14	57	0	170	0
PC124	2000	4-wire w/cages	849	0	170	0	0	0	0
PC132	2000	Pre-trt	0	0	57	0	0	0	0
PC133	2000	Pre-trt	5150	0	170	0	113	170	509
PC199	2000	Pre-trt	849	0	170	0	170	453	170
PC28	2000	Pre-trt	4188	113	226	0	170	226	566
PC29	2000	Pre-trt	792	170	0	340	0	0	226
PC30	2000	Pre-trt	4527	0	170	0	736	0	0
PC31	2000	Pre-trt	5659	0	170	0	170	170	113
PC34	2000	Pre-trt	6791	0	42	0	14	99	141
PC503	2000	4-wire	566	0	453	0	226	396	4357
PC513	2000	4 ft woven fence	2207	0	85	0	28	42	0
PC514	2000	Pre-trt	2829	0	226	0	170	170	1358
PC533	2000	Cages	283	0	0	0	57	170	0
PC537	2000	4-wire w/cages	99	0	42	0	0	0	0
PC539	2000	Big game fence	340	0	42	0	0	0	99
PC95A	2000	Pre-trt	57	0	325	0	42	269	57
PC95B	2000	Pre-trt	0	0	0	0	0	1415	283
PC96A	2000	Pre-trt	0	0	113	0	170	0	1132
PC96B	2000	Pre-trt	0	0	0	0	0	622	0

Appendix 4 cont.

Site	Conifer sub-dom/ha	Conifer co-dom/ha	Conifer dominant/ha	Aspen canopy cover (%)	Conifer canopy cover (%)	Aspen sprout-sap height lower (cm)	Aspen sprout-sap height upper (cm)	Aspen height co-dom (average)
PC07	340	566	170	4	44	10	50	14
PC106	170	57	226	14	50	10	40	16
PC117	0	42	340	4	52	n/a	n/a	12
PC123	0	0	170	5	34	10	30	12
PC124	0	0	0	4	21	10	25	12
PC132	962	0	1867	0	69	n/a	n/a	8
PC133	113	57	57	14	20	10	45	16
PC199	1019	226	0	5	21	10	30	12
PC28	340	226	0	10	30	10	100	22
PC29	905	0	0	18	42	10	30	22
PC30	0	0	57	1	26			9
PC31	340	57	226	15	33	20	100	12
PC34	85	0	57	5	31	15	30	17
PC503	113	0	0	25	15	40	40	16
PC513	0	71	0	11	10	40	150	16
PC514	340	283	0	4	21	50	200	15
PC533	0	0	283	0	29	20	40	n/a
PC537	71	99	57	9	38	10	30	24
PC539	0	28	28	6	21	10	45	16
PC95A	0	0	28	34	23	10	20	22
PC95B	509	0	113	0	51	n/a	n/a	n/a
PC96A	1924	0	0	12	41	n/a	n/a	20
PC96B	113	0	0	0.4	24	n/a	n/a	n/a

Appendix 4 cont.

Site	Conifer height co-dom (m) (average)	Conifer height dominant (m) (average)	Evidence of historic browse	Evidence of current year browse	Vigor A sprouts	Vigor adults	Landform	% Lost	% Slope	Position on slope
PC07	14	30	y	n	4	5	3	90	10	2
PC106	16	27	y	n	4	5	2	95	10	2
PC117	12	30	n	n	4	5	5	95	10	2
PC123		19	y	n	5	6	5	99	5	2
PC124		25	y	n	5	5	5	?	25	2
PC132		15	n/a		6	6	5	99	20	2
PC133	16	30	y	n	4	5	5	90	20	2
PC199	12	20	y	n	5	5	1	75	10	2
PC28	22		y	n	4	5	3	85	10	2
PC29			y	n	5	3	3	?	10	2
PC30		18	y	n	3	5	5	?	70	2
PC31	12	20	y	n	4	5	2	60	10	2
PC34	17	25	y	n	4	5	3	90	10	2
PC503		20	y	n	5	4	5	75	10	2
PC513	16	27	y	n	3	4	5	75	5	2
PC514	15	20	n	n	2	5	5	75	5	2
PC533		33	y	n	5	6	3	100	10	2
PC537	24	30	y	n	5	5	3	95	10	2
PC539	16	24	y	n	4	4	5	85	5	3
PC95A		28	y	n	4	3	5	70	25	2
PC95B		30	n/a		6	6	5	100	20	2
PC96A	n/a	n/a	n/a		6	5	3	90	10	2
PC96B		12	n/a		6	6	3	100	10	2

Appendix 4 cont.

Site	Aspect	Micro-relief	Comments
PC07	NE	2	Large # of suckers compared with adult aspen. Should respond well to treatment
PC106	S	2	
PC117	SW	2	
PC123	S	3	Some sub and co-dom conifer cut. Need to cut more conifer.
PC124	SE	2	Co-dom conifer cut. Suckers are being browsed. 7 cages not protecting very many potential suckers on site.
PC132	S	1	Single aspen on site; no down dead; question whether a stand or not.
PC133	E	3	
PC199	SW	3	
PC28	S	2	Adult aspen fading. Ample suckers would benefit from protection of herbivory.
PC29	S	3	
PC30	S	3	
PC31	SW	2	Severe hedging of suckers
PC34	W	2	Adult aspen nearly dead. A lot of suckers
PC503	SE	3	Fence not detering browsing
PC513	S	3	Suckers have hedged appearance. Signs of deer abundance. Fence broken by fallen trees.
PC514	SE	3	Suckers not browsed. Signs of snow damage…bent, contorted, etc. Not far from PC 513 which is browsed.
PC533	S	2	
PC537	SW	2	Few co-dom conifer cut
PC539	SE	2	
PC95A	SW	3	Fire scar
PC95B	S	2	High variability through draw; some alive others dead.
PC96A	S	2	
PC96B	S	3	Conifer dominance eminent. Sub-dom conifer present in alarming numbers. Few live co-dom aspen standing.

Appendix 4 cont.

Site	Date	Primary shrub	Cover class	Secondary shrub	Cover class	Primary grass	Cover class	Secondary grass
PC 07	2000					pinegrass	3	carex
PC 106	2000	ribes	1	snowberry	1	carex	2	kentucky bluegrass
PC 117	2000					carex pinegrass	3	
PC 123	2000	snowberry	1			carex	2	
PC 124	2000	snowberry	1			carex	2	pinegrass
PC 132	2000	snowberry	1			carex	1	
PC 133	2000	snowberry	2	prunus	1	carex	3	pinegrass
PC 199	2000	snowberry	1			carex	2	
PC 28	2000	snowberry	1			carex	2	
PC 29	2000	snowberry	1			carex	2	
PC 30	2000	sagebrush ribes	1	rosa prunus	1	bluebunch wheatgrass	2	poa
PC 31	2000	sagebrush	2			kentucky bluegrass	3	melica
PC 34	2000					carex	3	poa
PC 503	2000	snowberry	1	ribes	1	pinegrass	3	
PC 513	2000					carex	3	pinegrass
PC 514	2000					carex	2	pinegrass
PC 533	2000	ribes	2	rabbitbrush	1	kentucky bluegrass	2	
PC 537	2000					carex poa	2	
PC 539	2000	snowberry	2	ribes	2	carex	3	pinegrass orchard grass
PC 95A	2000	snowberry	1			kentucky bluegrass	2	carex
PC 95B	2000	snowberry	2			carex kentucky bluegrass	2	
PC 96A	2000							
PC 96B	2000					kentucky bluegrass	2	carex

Appendix 4 cont.

Site	Cover class	Primary forb	Cover class	Secondary forb	Cover class
PC 07	1	lupine arnica	2	meadowrue	1
PC 106	2	yarrow strawberry arnica	3		
PC 117		lupine	2	arnica	1
PC 123		arnica	1	lupine	1
PC 124	2	lupine	1		
PC 132		strawberry	1	lupine	1
PC 133	2	yarrow	1	senecio	1
PC 199		long leaf ?	3	false hellabore	2
PC 28		meadowrue	2		
PC 29		meadowrue	2		
PC 30		penstemon	1		
PC 31	2	arnica	2	lupine yarrow false solomon	2
PC 34	3	arnica	2	yarrow	1
PC 503		strawberry	2		
PC 513	2	lupine	2	strawberry arnica	2
PC 514	2	strawberry yarrow	2	lupine	2
PC 533		lupine	1	arnica	1
PC 537		dandelion	1	arnica	1
PC 539	1	yarrow	1		
PC 95A	1	hackleia	3	arnica	2
PC 95B	1	meadowrue, lily, hackleia	1		
PC 96A					
PC 96B	1	hackleia dandelion	1		

Appendix 5. Site-specific data for aspen sites inventoried in 2001.

Site	Date	Treatment	Plot #	Aspen sprout-sapling/ha	Aspen sub-dom/ha	Aspen co-dom/ha	Aspen standing-dead, sprout-sapling/ha	Aspen standing-dead, sub-dom/ha
4401009	2001	4-wire fence, 31 cages, burned		538	0	14	170	0
4401039	2001	4-wire fence; 6 cages;cut conifer		2377	14	28	156	0
4401042	2001	10 cages, cut conifers		538	0	14	14	0
4401045	2001	4-wire fence, 1 cage		99	28	0	28	0
4401047	2001	BG fence 2001		1995	0	42	141	14
4401055	2001	BG fence 2001	lower spg	2702	0	14	184	0
4401056	2001	BG fence 2001	upper spg	580	0	14	1429	0
4401073	2001	no trt		2292	28	85	42	0
4401077	2001	BG fence and planted		0	0	0	0	0
4401078	2001	BG fence and planted		17995	127	57	17542	269
4401079	2001	BF fence, planted, cut conifers		439	42	42	0	14
4401080	2001	BG fence and planted		1316	28	0	184	57
4401081	2001	older 4-wire, 19 cages,cut conifer		11883	0	0	5206	0
4401082	2001	BG fence; planted, cut conifer	1	3636	0	0	750	0
4401082	2001	BG fence; planted, cut conifer	2	43573	42	156	8035	552
4401083	2001	planted aspen in tubes		0	0	0	0	0
4401085	2001	7 cages & 1 condo in 2001		721	14	0	240	0
4401088	2001	14 cages& 3 tubes		509	0	0	0	0
4401090	2001	no trt		1358	340	0	962	0
4401093	2001	4-wire fence, 7 cages		2815	0	42	99	0
4401099	2001	electrice fence		5659	0	0	2773	0
4401121	2001	4-wire fence, 2 cages		566	14	42	85	0
4401122	2001	3 cages		0	0	0	0	57
4401127	2001	4-wire fence, 8 cages, cut conifer		2532	0	14	57	0
4401129	2001	2 condos		693	14	0	28	0
4401133	2001	no trt		1302	0	28	14	0

Appendix 5 cont.

Site	Date	Treatment	Plot #	Aspen sprout-sapling/ha	Aspen sub-dom/ha	Aspen co-dom/ha	Aspen standing-dead, sprout-sapling/ha	Aspen standing-dead, sub-dom/ha
4401167	2001	no trt		1584	0	156	198	0
4401199	2001	BG fence, cut conifers		3834	0	14	170	14
4401208	2001	no trt		16297	28	42	792	170
4401249	2001	BG (buck&pole); planted		707	28	14	57	71
4401250	2001	BG fence; planting		594	113	0	99	42
4401251	2001	no trt		2957	566	156	226	85
4401253	2001	14 cages & 12 tubes in 2001		962	0	0	509	57
4401331	2001	cattle fence, cages, cut conifer		3254	28	28	354	0
4401333	2001	3 cages		340	0	28	14	14
4401340	2001	3 cages, 1 condo		622	0	0	0	0
4401366	2001	3 cages		71	0	0	14	14
4401369	2001	no trt		1103	170	57	42	14
4401372	2001	9 tubes and 1 cage		1358	0	0	0	57
4401377	2001	no trt		1627	127	0	1287	113
4401415	2001	1condos& 2 tubes		283	0	0	0	0
4401491	2001	no trt		17882	1033	85	453	28
4401519	2001	10 cages		198	0	14	0	0
4401590	2001	2 cages		57	0	0	57	0
4401592	2001	no trt		1273	0	14	283	0
4401080A	2001	BG fence, plant, cut conifers		0	0	0	1669	255
4401089A	2001	4-wire fence & 3 cages		721	71	0	212	57
4401514A	2001	4-wire fence		849	156	0	679	28
4401514B	2001	BG fence	1	2391	156	0	99	0
4401514B	2001	BG fence	2	9394	1330	28	113	141

Appendix 5 cont.

Site	Aspen standing-dead, co-dom/ha	Aspen down-dead sprout-sapling/ha	Aspen down-dead sub-dom/ha	Aspen down-dead co-dom/ha	Aspen down-dead dominant/ha	Conifer sprout-sapling/ha	Conifer sub-dom/ha
4401009	0	0	0	0	0	396	14
4401039	0	0	0	0	0	212	57
4401042	0	0	14	28	0	226	14
4401045	42	0	0	85	0	424	170
4401047	14	0	14	14	0	212	14
4401055	0	0	42	0	0	325	1217
4401056	0	0	14	42	0	1132	891
4401073	0	0	42	28	0	127	255
4401077	0	0	0	0	0	566	170
4401078	0	0	0	42	0	184	792
4401079	0	0	28	0	0	481	28
4401080	0	0	28	0	0	255	269
4401081	14	0	28	0	0	1033	0
4401082	0	14	0	0	14	608	156
4401082	28	0	42	113	0	170	113
4401083	0	0	0	0	0	495	481
4401085	0	0	0	0	0	283	580
4401088	0	0	0	0	0	113	0
4401090	0	0	0	0	0	509	849
4401093	0	0	0	0	0	481	42
4401099	113	0	0	57	0	0	0
4401121	28	14	0	0	0	1740	127
4401122	0	0	14	0	0	1061	0
4401127	0	0	0	0	0	1075	0
4401129	0	0	14	0	0	1217	57
4401133	28	0	0	14	0	141	85

Appendix 5 cont.

Site	Aspen standing-dead, co-dom/ha	Aspen down-dead sprout-sapling/ha	Aspen down-dead sub-dom/ha	Aspen down-dead co-dom/ha	Aspen down-dead dominant/ha	Conifer sprout-sapling/ha	Conifer sub-dom/ha
4401167	0	0	28	14	0	184	99
4401199	28	0	57	28	0	156	0
4401208	28	0	57	28	0	340	198
4401249	0	28	28	0	0	693	269
4401250	0	0	0	0	0	113	170
4401251	85	0	28	57	0	1075	750
4401253	0	0	57	0	0	1867	170
4401331	14	0	28	14	0	57	0
4401333	14	0	0	14	0	240	57
4401340	28	0	0	0	0	693	99
4401366	0	0	14	0	0	198	509
4401369	0	0	14	28	0	863	156
4401372	0	0	226	340	0	57	57
4401377	71	0	28	28	0	778	707
4401415	0	0	0	0	0	566	2037
4401491	14	0	14	28	0	2150	99
4401519	0	0	42	28	0	85	99
4401590	0	0	0	0	0	4074	566
4401592	0	0	0	0	0	283	28
4401080A	14	141	0	14	0	212	85
4401089A	0	0	28	0	0	71	0
4401514A	14	0	42	28	0	2037	28
4401514B	0	14	0	0	0	679	42
4401514B	0	1811	0	0	0	226	806

Appendix 5 cont.

Site	Conifer co-dom/ha	Conifer dominant/ha	Aspen canopy cover (%)	Conifer canopy cover (%)	Aspen sprout-sap height lower (cm)	Aspen sprout-sap height upper (cm)	Aspen height co-dom (m) (average)	Aspen height dominant (m) (average)	Conifer height sub-dom (m) (average)
4401009	14	269	0	49	10	70	5		12
4401039	28	0	7	28	20	150	5		11
4401042	0	14	0	22	12	80	3		
4401045	240	28	0	66	8	88	3		10
4401047	14	57	6	28	30	n/a	11	20	
4401055	113	71	0	66	10	54	13		
4401056	42	99	9	57	10	40	12		
4401073	14	0	21	5	1	120	17		14
4401077	57	226	0	50			0		
4401078	28	14	9	17	5	90	11		
4401079	14	71	0	24	8	50	9		
4401080	28	14	11	23	10	100	9		
4401081	14	0	4	11	10	100	7		
4401082	0	0	1	11	4	150	24		16
4401082	0	0	37	6	25	45	21		
4401083	71	71	0	59			0		10
4401085	170	0	0	32	23	200	0		7
4401088	0	0	0	7	30	65	0		10
4401090	57	57	1	48	20	90	0		
4401093	28	57	4	33	7	31	6		8
4401099	0	0	0	0	5	50	8		
4401121	0	57	1	39	6	15	2		
4401122	0	14	0	58	4	23	7		
4401127	0	57	1	36	4	29	0		
4401129	141	0	3	51					
4401133	14	14	0	26	3	70	16		

Appendix 5 cont.

Site	Conifer co-dom/ha	Conifer dominant/ha	Aspen canopy cover (%)	Conifer canopy cover (%)	Aspen sprout-sap height lower (cm)	Aspen sprout-sap height upper (cm)	Aspen height co-dom (m) (average)	Aspen height dominant (m) (average)	Conifer height sub-dom (m) (average)
4401167	57	14	14	28			0		
4401199	0	57	7	24	7	50	18		11
4401208	0	14	16	2	31	200	10		9
4401249	42	14	4	41	27	130	2		
4401250	42	85	3	30	12	200	4		6
4401251	42	28	6	32	28	60	0		
4401253	0	0	0	48	2	80	6		6
4401331	42	42	0	24			0		
4401333	99	212	1	61	7	22	0		
4401340	85	14	0	28	11	200	0		13
4401366	297	99	0	79	20	200	6		18
4401369	85	141	0	35	20	150	0		9
4401372	57	0	0	18	40	190	5		
4401377	240	127	0	53	n/a		0		6
4401415	57	57	0	59	20	190	19		9
4401491	28	14	23	30	5	35	9		14
4401519	28	57	0	62	n/a	66	0		9
4401590	0	0	0	35	1	40	10		16
4401592	0	0	2	8			0		
4401080A	0	0	0	22	30	90	0		
4401089A	42	0	8	33	9	90	0		
4401514A	212	14	0	16	30	200	3		
4401514B	198	71	1	36	8	200	11		
4401514B	99	0	12	40	31	200	22		19

Appendix 5 cont.

Site	Conifer height co-dom (m) (average)	Conifer height dominant (m) (average)	Evidence of historic browse	% Historic browse	Evidence of current year browse	% Current year browse	Vigor A	Vigor	Vigor C	Landform
4401009	16	22	y	100	y	100	3	0	4	5
4401039	11	16	y	100	y	75	4	0	5	5
4401042	10	28	y	25	n		3	4	0	4
4401045	18	36	y	100	n/a		2	0	0	3
4401047	15	18	y	n/a	y	75	3	0	2	5
4401055	22	36	y	n/a	y	n/a	2	0	4	3
4401056	22	25	y	75	n		4	0	4	3
4401073	22	31	y	100	y	75	3	4	4	3
4401077	11	14	n/a				n/a	n/a	n/a	2
4401078	19	19	y	n/a	n		3	3	3	2
4401079	16	19	y	75	y	75	3	4	2	3
4401080	12	18	y	25	n		1	3	4	3
4401081	18	22	y	n/a	y	75	4	2	4	2
4401082	18	26	Y	25	N		2	0	3	5
4401082	22	30	y	50	n		1	0	2	4
4401083	19	25	n/a				0	0	0	3
4401085	19	37	y	75	y	100	2	0	0	5
4401088	14	29	y	100	y	75	2	0	0	3
4401090	17	28	y	100	y	100	4	2	0	5
4401093	12	20	y	100	y	50	4	4	0	5
4401099			y	100	y	100	3	0	5	3
4401121	11	26	y	100	y	75	3	0	5	5
4401122	15	23	n/a				3	0	0	5
4401127	16	25	y	100	y	75	3	0	6	5
4401129	20		y	100	y	100	3	0	6	5
4401133	17	31	y	100	y	100	3	0	5	5

Appendix 5 cont.

Site	Conifer height co-dom (m) (average)	Conifer height dominant (m) (average)	Evidence of historic browse	% Historic browse	Evidence of current year browse	% Current year browse	Vigor A	Vigor	Vigor C	Landform
4401167	14	25	y	100	y	100	4	0	3	4
4401199	19	24	y	25	n		2	4	4	2
4401208	22	31	y	100	y	50	4	4	3	1
4401249	18	20	n/a				4	1	1	3
4401250	10	16	y	25	n		2	5	5	3
4401251	13	23	y	75	y	75	3	2	6	2
4401253	15	26	y	75	y	75	3	0	0	3
4401331	15	18	y	100	y	100	4	5	5	4&2
4401333	17	28	y	100	y	100	4	0	6	5
4401340	18	24	y	75	y	25	3	0	0	5
4401366	22	32	y	50	y	25	2	0	0	5
4401369	13	20	y	50	y	25	2	2	4	3
4401372	11	20	y	25	y	25	2	0	0	3
4401377	14	23	y	100	y	100	4	4	4	5
4401415		28	y	100	y	100	2	0	0	5
4401491	25	33	y	100	y	100	1	1	2	5
4401519	13	28	y	100	y	100	4	0	5	3
4401590	22	42	y	100	y	100	3	0	0	5
4401592	26		y	100	y	100	4	0	4	5
4401080A	9		n/a		n		6	0	6	4&3
4401089A	18	47	y	25	n		3	0	0	5
4401514A	17	29	y	100	y	25	3	0	5	2 or 5?
4401514B	14	21	y	75	n		1	0	2	2 or 5?
4401514B	22	28	y	50	n		1	0	3	2 or 5?

Appendix 5 cont.

Site	% Lost	% Slope	Position on slope	Aspect	Micro-relief
4401009	90	13	1	SE	1
4401039	80	32	2	SW	2
4401042	95	6	3	W	3
4401045	95	0	3	ENE	3&1
4401047	85	14	2	E	1 and 2
4401055	90	8	3	W	1 and 3
4401056	90	15	3	W	1
4401073	85	n/a	3	SW	2
4401077	100	5	3	NW	2
4401078	70	1	3	NNW	3
4401079	40	2	3	NNE	2
4401080	60	2	3	N	3
4401081	70	10	3	SE	2
4401082	70	1	2	N	3
4401082	70	0	2	N	3
4401083	100	10	2	N	1
4401085	20	54	2	SW	1&2
4401088	90	4	3	NW	3
4401090	95	50	2	W	2
4401093	90	10	2	N	1
4401099	90	3	3	SSW	1&3
4401121	90	16	2	W	1
4401122	90	20	2	E	1
4401127	90	8	1	SSW	1&2
4401129	90	0	2	E	3
4401133	90	23	1	E	1

Site	% Lost	% Slope	Position on slope	Aspect	Micro-relief
4401167	90	4	3	S	3
4401199	50	4	3	SW	1&3
4401208	35	2	3	E	3
4401249	40	4	3	E	1
4401250	99	4	3	NW	2
4401251	80	4	3	NW	3
4401253	85	3	3	NW	3
4401331	40	7	3	WSW	1 and 3
4401333	90	4	1	E	1
4401340	98	3	1	S	2
4401366	99	4	2	N	2
4401369	30	8	3	SSE	1
4401372	95	n/a	3	N	2
4401377	90	5	3	SW	3
4401415	50	25	3	W	1
4401491	20	2	3	W	3
4401519	99	5	2	SW	2
4401590	99	14	3	NE	1
4401592	95	1	3	E	3
4401080A	100	9	3	SSE	1 to 3
4401089A	50	70	2	SW	1
4401514A	95	4	3	E	3
4401514B	80	0	3	E	1
4401514B	60	1	3	E	3

Site	Comment
4401009	has been underburned in past; conifers designated "dom" to adult aspen were approx 10ft taller, vigor of apsen in cages in upper group seems better than in lower group
4401039	plot center 11 ft uphill from cage between aspen and PIPO
4401042	
4401045	sprout/saplings within cages are in rough shape; sagebrush, squaw currant and juniper abundant outside of plot
4401047	looks like a ripper went through about 10% of this site a few years ago???
4401055	
4401056	spring has been piped underground to trough outside BG fence
4401073	high variety of forbs;evidence of elk and deer
4401077	no apparent evidence of previous existence of aspen
4401078	
4401079	deeply incised drainage;currently dry
4401080	
4401081	across road are more sprouts and standing dead aspen
4401082	many compositics present; numerous dead down aspen (co-dom)outside plot; no recently-cut conifer within the plot (old cuts), but a lot at edges and beyond aspen
4401082	significant recent conifer removal (sub-dom PICO) at edges and beyond aspen stand proper
4401083	slope is 16% up the side slopes of this dry stream; 2 small cottonwoods exist upslope next to road
4401085	Evidence of fire; rocky outcrop; honeysuckly&oregon grape also present; plot center in middle of cages
4401088	stream runs through plot; all adult conifers on one side of stream
4401090	plot done on east side of road
4401093	
4401099	site burned, no adult trees; stream flows through plot; outside plot is sagebrush
4401121	plot center between fir and aspen on fence
4401122	dominancy based on existing conifers only, since no adult aspen
4401127	
4401129	
4401133	rocky outcrop; not much vegetation; on 9-20-01 plot revisited to place stake:4-wire fence, cages&condo installed. Info for this plot prior to treatment

Appendix 5 cont.

Site	Comment
4401167	cattle are in, so difficult to determine grass species; plot location:park on rd 456, walk
4401199	bg fence extends beyond our GPS perimeter by 80-100 m on east side; a lot of biomass of cut conifers lies within the plot; numerous cut conifers otside plot
4401208	
4401249	approx 30% slope begins 5-6 m south of creek to fenceline; aspen leaves have brown spots and appear to be dying
4401250	high level of understory diversity; 80-90% grass cover with numerous sp
4401251	
4401253	14 cages total and 12 tubes; fresh elk droppings; plot center in western group
4401331	deer sign; severely hedged sprouts/saps; a 118 cm dbh PIPO within the exclosure
4401333	looks like underburn went through at some time; primarily needles and fuel debris as ground cover
4401340	plot center is between 2 cages and condo; looks like possible underburn done
4401366	dominacy based on existing conifers only, since no adult aspen
4401369	plot center by rocks in middle of aspen stand/open space
4401372	Deer beds observed; trees felled by beaver
4401377	bear marks; plot center between dom PIPO and big stump
4401415	condo is approximately 18 ft X 8 ft
4401491	evidence of fire; deer beds
4401519	slash piles on plot and in surrounding area; only 1 adult aspen on site and plot
4401590	elk sign; plot center is between cages
4401592	heavily grazed and compacted presumably by cattle; all dom conifers dead ? (this might be a transcription error, it might mean "all dom aspen" dead
4401080A	conifer designation: co and sub-dom relative only to existing conifers within the plot, since no aspen exist but conifer would be sub-dom to standing deas aspen
4401089A	site is rocky outcrop with cliffs;dominance assessed relative to conifers present since stand lacks "adult" aspen; 9 cages within 4-wire fence; mostly shrubs, few forbs
4401514A	
4401514B	
4401514B	

Appendix 5 cont.

Site	Date	Primary shrub	Cover class	Secondary shrub	Cover class	Primary grass	Cover class
4401009	2001					Carex	3
4401039	2001	snowberry	1			Carex	3
4401042	2001					Carex	5
4401045	2001	snowberry	1			Carex	4
4401047	2001	snowberry	1			fescue	6
4401055	2001	oregon grape	1			Carex	5
4401056	2001					Carex	2
4401073	2001	Currant sp.				Carex	5
4401077	2001	snowberry	2	potentilla	1	Carex	3
4401078	2001	snowberry	4			Agropyron	5
4401079	2001	snowberry	4				5
4401080	2001	snowberry	4			Elymus canadensis	6
4401081	2001	ARUV	2	Rosa sp.	1	Carex	5
4401082	2001	Symphoricarpos	1	Rosa sp.	1	Carex	5
4401082	2001	Symphoricarpos	1	Rosa sp.	1	Carex	5
4401083	2001	grouse huckleberry/twinflower	4	huckleberry/currant	4	pine grass	5
4401085	2001	kinik-kinik	4	snowberry	3	elk sedge	3
4401088	2001	Currant sp.	2	Rosa sp.	1		
4401090	2001	snowberry	2	kinik-kinik	2	Carex	1
4401093	2001					Carex	2
4401099	2001	snowberry	2			poa	4
4401121	2001	snowberry	2	Oregon grape	1	poa	3
4401122	2001	snowberry	1			Carex	7
4401127	2001					Carex	6
4401129	2001	speciman	1			Carex	6
4401133	2001	snowberry	3	current/oregon grape	3	Carex	5
4401167	2001	snowberry	1			Carex	6
4401199	2001					Carex	4
4401208	2001					Carex	5
4401249	2001	hawthorne	5	alder	3	carex	5
4401250	2001	Currant sp.	2	snowberry	2	Carex	4
4401251	2001	snowberry	3		3	Carex	6

Appendix 5 cont.

Site	Date	Primary shrub	Cover class	Secondary shrub	Cover class	Primary grass	Cover class
4401253	2001	snowberry	2	alder	2		4
4401331	2001	sagebrush	2	snowberry	1	fescue	6
4401333	2001	oregon grape	1			Carex	2
4401340	2001	snowberry	1			Carex	5
4401366	2001					Carex	2
4401369	2001	snowberry	4	alder	4	Carex	5
4401372	2001	alder	2	snowberry	2		
4401377	2001	Currant sp.	1			elk sedge	4
4401415	2001	grouse huckleberry	6	kinik-kinik	3	elk sedge	2
4401491	2001						5
4401519	2001	Currant sp.	1			elk sedge	4
4401590	2001					elk sedge	6
4401592	2001					Poa	6
4401080A	2001	ARUV/RIVI	5	snowberry	2	Carex	6
4401089A	2001	honeysuckle	5	grouse whortleberry	4	Carex	1
4401514A	2001	Rosa sp	3	Oregon grape	2	Carex	6
4401514B	2001					Carex	7
4401514B	2001					elk sedge	6

Appendix 5 cont.

Site	Secondary grass	Cover class	Primary forb	Cover class	Secondary forb	Cover class
4401009			lupine/strawberry/aster	2		
4401039	fescue	3	Scropholariacae	4	Trifolium sp	3
4401042	Poa	4	Veratrum californicum	5	Trifolium sp	3
4401045	Poa	3	aster sp	3	strawberry	2
4401047	fescue		lupine	1	yarrow	1
4401055			arnica	4		
4401056	carex	2	arnica	3		
4401073		4	Gultheria sp	5	yarrow	3
4401077			geranium sp	1		
4401078	Poa pretensis	4	Potentilla gracilus	1	yarrow	1
4401079		5		3		2
4401080	carex	3	yarrow	3	Solidago	
4401081	Poa	4	FRVI	1	VIGL	1
4401082	Poa	3	Iris sp.	4	VECA	3
4401082	Poa	4	Galium sp	5	Smilacina stellata	3
4401083			strawberry/aster/yarrow	6	meadowrue	6
4401085			Fragaria sp	1		
4401088			Rannunculus sp.	1	Fragaria sp.	1
4401090			fireweed	1	pussytoes	1
4401093	Poa	1	thistle	2	arnica	1
4401099			thistle	3		
4401121			yarrow	2	thistle	1
4401122			lupine	2		2
4401127	fescue	2	arnica	1		
4401129			yarrow	1		
4401133			composite sp	1	yarrow	1
4401167			lupine	2	strawberry	1
4401199	Poa	3	iris/aster sp	5	yarrow/strawberry	3
4401208				5	iris/false helibore	3
4401249	poa	2				
4401250			thistle	2	yarrow/aster	2
4401251	Poa	2	starry false solomans seal	4	galium sp	2

Appendix 5 cont.

Site	Secondary grass	Cover class	Primary forb	Cover class	Secondary forb	Cover class
4401253	elk sedge	3	strawberry&aster	4	yarrow	3
4401331	fescue		strawberry	2	lupine	2
4401333	Poa	1				
4401340			Fragaria sp	1	pussytoes	1
4401366			arnica	1		
4401369	fescue	2	aster sp	4	goldenrod	3
4401372			Galium sp	2	Mullen	1
4401377			Fragaria sp	2	sweet cicely	1
4401415						
4401491		4	false solomans seal	4	Fragaria sp.	2
4401519			strawberry	2	yarrow	1
4401590			pussytoes&strawberry	3		
4401592			Fragaria sp	1	lupine	1
4401080A	cheat grass	3	yarrow	3		3
4401089A						
4401514A			Fragaria sp	4	lupine	4
4401514B			Fragaria sp	4	lupine	3
4401514B			Fragaria sp	6	lupine	5

Appendix 6 Site-specific data for aspen re-visit sites inventoried in 2001.

Site	Treatment	Live aspen outside cages	Live aspen/ha outside cages	# Aspen Sub-dom	# Aspen Sub-dom/ha	# Conifer Sapling	# Conifer Sapling/ha
4401015	cages, condo	0	0	0	0	2	113
4401014	cages only	0	0	0	0	8	452
4401007	cages only	33	1864.5	0	0	15	847.5
4401511	3-rail wooden fence	130	7345	2	113	6	339
4401095A	No treatment	11	621.5	0	0	1	56.5
4401095B	No treatment	2	113	0	0	17	960.5
4401096	No treatment	0	0	0	0	1	56.5
4401032	No treatment	4	226	1	56.5	11	621.5
4401025	4-wire, cages, cut, no burn	50	2825	0	0	2	113
4401026	4-wire, cages, no cut, no burn	73	4124.5	0	0	2	113
4401502	4-wire, cages, no cut, no burn	1	56.5	0	0	3	169.5
4401517	rail fence allows BG in	59	3333.5	13	734.5	2	113
4401013	4-wire, cages, no cut, no burn	73	4124.5	0	0	11	621.5
4401531	cages only	10	141.4	0	0	19	268.66
4401527	cages only	20	282.8	0	0	8	113.12
4401510	BG cut, burn	365	5161.1	0	0	0	0
4401032	No treatment	34	480.76	0	0	1	14.14
4401033	No treatment	16	226.24	0	0	0	0
4401028	No treatment	413	5839.82	0	0	4	56.56
4401029	No treatment	42	593.88	8	113.12	30	424.2
4401034	No treatment	129	1824.06	0	0	6	84.84
4401027	BG, cut, no burn	542	7663.88	0	0	9	127.26
4401506	BG, cut, no burn	104	1470.56	0	0	3	42.42
4401539	BG, cut, no burn	124	1753.36	0	0	15	212.1
4401509	4-wire, cages, moved trough	2	28.28	0	0	2	28.28
4401036A	4-wire, cages, moved trough	30	424.2	0	0	15	212.1
4401036B	4-wire, cages, moved trough	52	735.28	0	0	14	197.96

Appendix 6 cont

Site	Treatment	Live aspen outside cages	Live aspen/ha outside cages	# Aspen Sub-dom	# Aspen Sub-dom/ha	# Conifer Sapling	# Conifer Sapling/ha
4401011	4-wire, cages, cut, no burn	6	84.84	0	0	12	169.68
4401010	4-wire, cages, cut, no burn	83	1173.62	0	0	3	42.42
4401019	4-wire, cages, cut, no burn	11	155.54	0	0	32	452.48
4401524	4-wire, cages, cut, no burn	84	1187.76	0	0	14	197.96
4401123	4-wire, cages, cut, no burn	15	212.1	0	0	58	820.12
4401124	4-wire, cages, cut, burn	88	1244.32	0	0	5	70.7
4401016	4-wire, cages	98	1385.72	0	0	37	523.18
4401017	4-wire, cages	3	42.42	0	0	42	593.88
4401018	4-wire, cages	165	2333.1	0	0	39	551.46
4401501	4-wire, cages, no cut, no burn	0	0	0	0	17	240.38
4401518	4-wire, cages, no cut, no burn	10	141.4	0	0	45	636.3
4401505	4-wire, cages, aspencut, no burn	7	98.98	1	14.14	303	4284.42
4401537	4-wire, cages, no cut, no burn	9	127.26	0	0	0	0
4401031	4-wire, cages, no cut, no burn	151	2135.14	0	0	2	28.28
4401038	4-wire, cages, no cut, burned	35	494.9	0	0	0	0
4401038B	4-wire, cages, no cut, burned	31	438.34	0	0	7	98.98
4401508	BG no cut, no burn	154	17386.6	0	0	1	112.9

Appendix 6 cont.

Site	Aspen sprout height, lower (cm)	Aspen sprout height, upper (cm)	# Cages	Live aspen inside cages	# Condo	# Aspen in condo	# Empty cages	Vigor A inside cages
4401015	n/a	n/a	8	18	1	12	1	3
4401014	n/a	n/a	4	2			2	3
4401007	10	50	3	9				2
4401511	15	60						
4401095A	5	20						
4401095B	20	30						
4401096	n/a	n/a						
4401032	5	10						
4401025	10	40	4	12			0	2
4401026	5	30	9	41			0	2
4401502	10	10	5	6			0	2
4401517	10	50	1	n/a			1	n/a
4401013	10	20	8	56			0	2
4401531	20	50						
4401527	10	30	8	30				2
4401510	30	250						
4401032	5	20						
4401033	5	15						
4401028	10	30						
4401029	20	200						
4401034	5	40						
4401027	40	100						
4401506	40	250						
4401539	15	220	2	9				1
4401509	5	5	4	4			3	n/a
4401036A	5	20	8	34			0	2
4401036B	5	20	13	35			0	2

Appendix 6 cont.

Site	Aspen Sprout Ht, lower (cm)	Aspen Sprout Ht, upper (cm)	# Cages	Live aspen inside cages	# Condo	# Aspen in condo	# Empty cages	Vigor A inside cages
4401011	5	10	14	53			0	2
4401010	10	60	10	33			0	3
4401019	10	40	13	27			3	2
4401524	10	250	7	8			0	2
4401123	5	70	19	31			0	2
4401124	5	100	9	13			2	2
4401016	5	50	8	47			0	2
4401017	5	30	7	11			0	2
4401018	5	30	14	36			0	2
4401501	n/a	n/a	8	4			6	2
4401518	5	40	14	25			0	2
4401505	10	50	4	15			2	1
4401537	5	10	6	14			1	2
4401031	5	70	13	19			2	2
4401038	5	15	10	26			0	2
4401038B	5	10	9	14			0	2
4401508	10	200						

Appendix 6 cont.

Site	Aspen height inside cages, lower (cm)	Aspen height inside cages, upper (cm)	Aspen sub-dom inside cages	Vigor A	Vigor B	Vigor C	% Browsed historic	% Browsed current year
4401015	40	60		0	0	6	n/a	n/a
4401014	40	50		0	0	6	n/a	n/a
4401007	40	100		4	0	5	100	100
4401511				4	3	3	100	100
4401095A				4	0	5	100	100
4401095B				5	0	6	100	100
4401096				0	0	5	n/a	n/a
4401032				4	4	0	100	100
4401025	40	140		3	0	5	100	100
4401026	15	150		3	0	5	100	100
4401502	50	300	1	4	0	6	100	100
4401517	n/a	n/a		4	3	3	100	100
4401013	30	240		3	0	5	100	100
4401531				5	0	4	100	100
4401527	10	160		5	0	5	100	100
4401510				1	0	6	90	0
4401032				4	0	4	100	100
4401033				5	0	4	100	100
4401028				4	0	4	100	100
4401029				4	3	2	100	100
4401034				4	0	5	100	100
4401027				3	0	4	75	0
4401506				1	0	4	75	0
4401539	15	220		1	0	3	50	0
4401509	50	50		5	0	4	0	0
4401036A	20	100		4	0	3	100	100
4401036B	20	100		4	0	4	100	100

Appendix 6 cont.

Site	Aspen height inside cages, lower (cm)	Aspen height inside cages, upper (cm)	Aspen sub-dom inside cages	Vigor A	Vigor B	Vigor C	% Browsed historic	% Browsed current year
4401011	20	240		4	0	2	100	100
4401010	30	100		4	0	5	100	100
4401019	20	150		4	0	5	100	100
4401524	10	250		3	0	5	100	100
4401123	5	160		3	0	5	100	100
4401124	5	150		4	0	5	100	100
4401016	n/a	n/a		4	0	4	100	100
4401017	15	50		3	0	4	100	100
4401018	30	199		4	0	4	100	100
4401501	15	60		0	0	5	n/a	n/a
4401518	30	210		3	0	5	100	100
4401505	40	350	9	5	5	4	100	100
4401537	50	100		3	0	5	25	25
4401031	5	80		3	0	5	100	100
4401038	5	15		4	0	6	100	100
4401038B	15	70		4	0	5	100	100
4401508				1	0	3	50	0

Appendix 6 cont.

Site	Comments
4401015	No fence, cage/condo only; different than listed
4401014	cages only, not what is listed
4401007	saps heavily hedged
4401511	Not BG fence as listed (4-wire); saps heavily hedged; subs heavily marked on trunks; crowns great.
4401095A	Upper plot (0.4 mile from 1675); fallen dead adults numerous, at least 10 on plot.
4401095B	Lower plot (0.3 mile from 1675); fallen dead adults numerous, only 2 standing dead.
4401096	high cattle impact; plot center near road.
4401032	treatment different than list. basically stand is one sub-dominant aspen? (not clear from notes)
4401025	
4401026	plot center in middle of cages
4401502	riparian fence. Other cages don't have aspen in them.
4401517	buck and pole fence, but allows BG inside; aspen sub-dom healthy in additional cages.
4401013	
4401531	Different than listed
4401527	everything outside cages mostly dead. Plot center in 3rd group.
4401510	saps hedged heavily in past, now healthy. 2 dominant conifers
4401032	Heavily grazed area; barely any leaves on aspen sprouts;GPSR091321B
4401033	heavily grazed riparian area; aspen sprouts barely alive with black leaves; GPS R091322A
4401028	heavy hedging; most live sprouts have no leaves
4401029	heavy hedging.
4401034	heavily grazed by cattle.
4401027	all aspen sprouts have black spots on leaves; didn't match exactly on map, could be 504
4401506	aspen sprouts look great.
4401539	2 cages with 9aspen sprouts inside, same ht range and vigor?
4401509	lots of fallen aspen adults
4401036A	plot center north end; cut conifer, road closed that went through stand
4401036B	plot center south end by pond; land more trampled from cattle that 36A; heavy hedging.

Appendix 6 cont.

Site	Comments
4401011	
4401010	
4401019	labeled as no cut, but 4 conifer cut
4401524	
4401123	different than list
4401124	different than list
4401016	16,17,18 all inside same fence; lots of black bark crud.
4401017	16,17,18 all inside same fence; lots of black bark crud.
4401018	small area was once burned, aspen sprouts doing well.
4401501	riparian fence (not just for aspen); 11 surrounding cages.
4401518	
4401505	aspen cut.
4401537	cottonwood sapling?? Excluding cages, aspen growth has almost stopped; some black leaf spots.
4401031	
4401038	burned entirely
4401038B	burned in approximately 9 m^2 area; lots of adult conifer
4401508	saps hedged in past, now healthy

Appendix 7. Condition of aspen in cages and numbers of cut conifers on plot for n=31 sites surveyed in 2001.

Site	Treatment	Planted in Tubes	Planted Aspen, Live	Planted Aspen, Dead	Ht Aspen lower (cm)	Ht Aspen upper (cm)	# Condos	# Aspen in Condo	# Cages	# Aspen in Cages
4401009	4-wire, cages, burned								8	33
4401039	4-wire, cages, cut conifer								6	25
4401042	cages, cut conifers								10	27
4401045	4-wire, cages								3	8
4401077	big game and planted		17							
4401078	big game and planted		15							
4401079	big game, planted, cut conifer		13	5	60	70				
4401080	big game and planted		11	1	n/a					
4401081	older 4-wire, cages, cut conifer								16	5
4401082	big game, planted, cut conifer		23	0					0	
4401083	planted aspen in tubes	32			42	81				
4401085	cages, condo						1	14	7	20
4401088	cages, tubes								14	16
4401093	4-wire, cages								7	34
4401121	4-wire, cages								2	17
4401122	cages								3	4
4401127	4-wire, cages, cut conifer								8	21
4401129	condos						2	13		
4401249	big game (buck/pole), planted	9								
4401250	big game, planted		11	5	20	75				
4401253	cages, tubes								3	3
4401331	4-wire, cages, cut conifer								11	22
4401333	cages								3	3
4401340	cages, condo						1	10	3	3
4401366	cages								3	6
4401372	tubes, cage								1	1
4401415	condo, tubes						1	9		
4401519	cages								10	28
4401590	cages								2	2
4401080A	big game, planted, cut conifer		4	5						
4401089A	4-wire, cages								3	9

Appendix 7 cont.

Site	Ht in Cages lower (cm)	Ht in Cages upper (cm)	# Aspen in Tubes	Ht in Tubes lower (cm)	Ht in Tubes upper (cm)	Cut Conifer Sapling	Cut Conifer Sub-dom	Cut Conifer Co-dom	Cut Conifer Dom	Cut Conifer Unknown Size
4401009	10	80								
4401039	20	130					3		1	
4401042	4	32								
4401045	62	200								
4401077										
4401078										
4401079						24				
4401080										
4401081		500				n/a				
4401082										
4401083										
4401085	120	200								
4401088	40	170	1	60	70					
4401093	10	130								
4401121	n/a									
4401122	20	20								
4401127	41	79								5
4401129	10	30								
4401249				50	65					
4401250										
4401253	40	70								
4401331	n/a									10
4401333	n/a									
4401340	17	72								
4401366	17	36								
4401372			8	55	100					
4401415			2							
4401519	23	145								
4401590	40	80								
4401080A						4	5	2	0	
4401089A	20	50								

Appendix 8. GPS file names for sites surveyed in 2001.

Site	Date	Plot #	GPS file	Comments
4401082	7/27/01		R072720A	gps for plot center
4401250	8/8/01		n/a	
4401251	8/8/01		n/a	
4401369	8/15/01		n/a	
4401372	8/15/01		n/a	
4401249	8/8/01		n/a	
4401088	7/30/01		R091221B	gps for plot center
4401089A	7/30/01		R091221A	gps for plot center
4401253	8/15/01		R091221C	gps for plot center
4401415	8/14/01		R091222A	gps for plot center
4401083	8/9/01		R091222B	gps for plot center
4401085	8/14/01		n/a	
4401077	7/13/01		R071321A	gps for plot center
4401078	7/13/01		R071320A	gps for plot center
4401079	7/12/01		R071219A	gps for plot center
4401080	7/11/01		R071122A	gps for plot center
4401080A	7/16/01		R071620A	gps for plot center
4401080A	7/16/01		R071621A	gps for perimeter
4401081	7/10/01		R071617A	gps for plot center
4401090	8/14/01		n/a	
4401366	7/29/01		n/a	
4401047	7/17/01		n/a	
4401331	7/17/01		R071720A	gps for plot center
4401491	8/13/01		R091317A	gps for plot center
4401514A	7/26/01		R091317B,R072618A	gps for plot center
4401514B	7/26/01		R091318A, R072619B	gps for plot center
4401377	8/13/01		R091319A	gps for plot center
4401592	7/31/01		R091320A	gps for plot center
4401167	7/30/01		R091319B	gps for plot center
4401073	7/31/01		R091320B	gps for plot center
4401055	7/18/01	lower spring	R072522A	gps for plot center
4401129	8/7/01		n/a	
4401590	8/11/01		n/a	
4401039	8/11/01		n/a	
4401340	8/11/01		n/a	
4401208	8/11/01		n/a	
4401121	7/29/01		n/a	
4401093	7/29/01		n/a	
4401099	7/29/01		n/a	
4401056	7/18/01	upper spg	R072522B	gps for plot center
4401042	7/25/01		R072521B	gps is perimeter
4401042	7/25/01		R072521A	gps is plot center
4401199	7/27/01		R072816A	GPS is plot center
4401199	7/27/01		R072817A	gps is perimeter
4401045	7/28/01		R072820A	gps for plot center
4401127	8/7/01		n/a	
4401333	8/7/01		n/a	
4401122	8/7/01		n/a	
4401519	8/8/01		n/a	
4401009	8/16/01		n/a	
4401133	8/8/01		n/a	
"n/a"	not available			

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